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Development of District Steam Heating

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SUPPLYING heat energy from a central generating plant through underground pipes to the buildings in a city district is a form of public utility service which has been known in this country for many years. Although the energy so supplied is used primarily for heating, it is also used for the operation of engines and pumps, for cooking, for heating service water, and for process work.

During the past few years there has been a distinct improvement in the status of district heating, due principally to two causes. First is the increased value or cost for space occupied by the individual plant in large buildings due to increased congestion in the central districts of large cities.

The second cause is a greater appreciation on the part of the public of the luxury value of steam service. The freedom from dirt, smoke and annoyances which accompany the operation of the individual heating plant is attractive to the building owner and tenant. This freedom is often of tangible value, and consequently the building owner has been more willing recently to pay for district heating service.

The individual boiler plant is a competitor of district heating service. In cases where a building has not been erected the district heating service, by eliminating some of the investment and increasing the available useful floor area, can generally compete successfully with the individual plant. The unproductive space occupied by the boiler plant in the basement and by the chimney on each floor may be freed for rental purposes through the purchase of district steam service or a combination of steam and electrical service.

When all of the items bearing upon the cost of steam service are considered and fairly evaluated, the cost of the service compares favorably with the cost of producing steam in an isolated plant. In fact the annual rental value of the space released by the elimination of the boiler plant may equal the entire cost of district heating service for the building. This is particularly true in the so-called "tower" type of building.

The increasing desire to be relieved of the production of all classes of service which can be purchased, oftentimes influences the payment of a price which in some cases may be somewhat higher than the bare tangible cost of providing a less complete service. Incidentally, there is a real civic advantage in the elimination of smoke, dirt and traffic obstructions caused by the handling of fuel and ashes at the individual plant.

Thermal Efficiency

The overall thermal efficiency of district heating compares favorably with other methods of heating and is higher than appears in the case of the gas or electric utilities. The thermal efficiency of a well designed district heating plant varies from 75 to 85%, depending upon the density of load on a system which is in a good state of repair. The efficiency of the utilization of the heat in the consumer's premises is at least 90% and when the heat contained in the condensate is salvaged, the efficiency may rise to 95%.

Assuming averages of 80% for the district boiler plant, 85% for the distribution system, and 93% for th the efficiency of utilization, the overall efficiency becomes 63%. This exceeds the overall efficiency of the individual building heating plant which averages 50% for small buildings and 60% for larger buildings. District heating can thus be credited with an appreciable degree of saving in fuel consumption as compared with the individual plant, a point which may become worthy of more serious consideration in the future.

There are now three rather distinct fields in which district heating is employed, each involving different economic and engineering considerations.

a. Service to congested business and residential districts.

b. Service to districts of individual family residences.

c. Service to grouped industries.

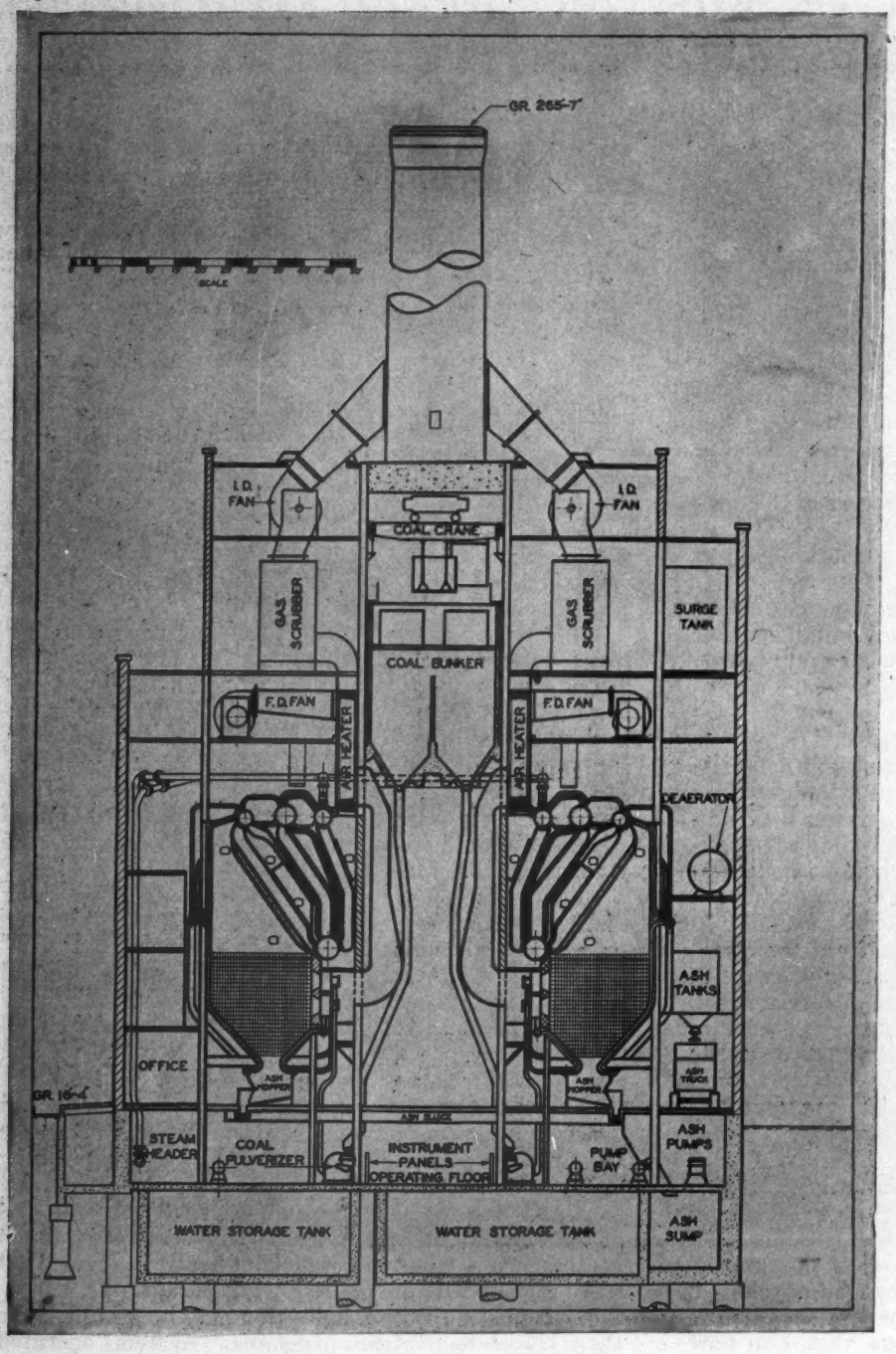
District steam service in the congested business districts is by far the most important considering the amount of capital invested and the amount of building space heated. Such districts constitute a particularly favorable field because of the high density of load, and also because the demand for the service is much greater. It is this type of district heating service that will be dealt with in the following paragraphs.

Systems of steam distribution may be grouped into three classes as to steam pressures. Systems operated at 50 pounds per square inch and less are called low

pressure systems. Those carrying pressures of 100 to 200 pounds are called high pressure systems. A third class has both high and low pressure pipes laid parallel to each other. The design pressure is determined by the probable requirements of the consumers, the amount of space available below the streets for pipes, and the policy of the company supplying the service.

Boiler Plants

Since some of the district heating projects are controlled by the operators of electric power plants, it is but natural that the boiler plant practice should follow rather closely that of the steam electric generating station. There are, however, a few fundamental conditions peculiar to district heating which affect the design.



Cross-section of Steam Heating Station S-2

The most important of these is the comparatively low average load to be carried in comparison to the maximum demand. The average load factor of space heating in this climate is from 18% to 19%. System average load factors vary from 22% to 30%. For this reason it is in many instances not considered economical to install economizers for removing the heat from chimney gases to heat feed water or install air heaters to preheat the air used for combustion.

As it is rarely economical to return the condensation of consumers to the boiler plant, elaborate chemical treatment of the raw water used in the boilers is necessary. Also where boilers are operated at high ratings deaeraters are necessary to remove the oxygen from the feed water before it is delivered to the boilers to prevent corrosion.

Field for District Heating

District heating boiler plants are designed for maximum efficiency at normal loads and usually the boilers are equipped with oversized furnace and fuel burning equipment to permit operation of the boilers at high ratings during peak periods, thereby reducing the capital charges per pound of capacity. Another condition that affects the design of heating plants is location, which, of necessity, is usually the centers of cities where land is costly and the area of the site is consequently restricted. The plant must, therefore, be selected with due regard to land economy.

In some district heating plants electric generating units are installed through which the steam is passed before being distributed for heating purposes. The question as to whether or not the generation of electricity as a by-product is economical or otherwise desirable cannot be definitely stated, but must be decided in each individual case on the basis of local considerations.

The gain in overall thermal economy which results by generating electricity from steam which is subsequently used for heating, as compared with generating an equivalent quantity of electricity in a condensing plant is well appreciated. There are, however, other economic and financial considerations which have in some instances led engineers to believe that the use of steam direct from the boilers for heating is the most desirable method.

The correct solution in any particular case depends upon the value of the kilowatt-hour at the location of the heating plant as compared with the total cost of producing it in the heating plant. Unless steam driven auxiliaries are

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Engineering the Modern Newspaper

BY ARTHUR H. BURNS

Mechanical Engineer, New York Herald-Tribune

THE production of the modern newspaper may be aptly described as the manufacture of an article of every day life of great value today and worthless tomorrow. Such a transitory existence demands that each issue be complete in quantity and quality of the most timely news. To obtain this result, manufacturing of a newspaper must be performed in accordance with a rigid time schedule, a requirement demanded of very few manufacturing operations. Another variation from the ordinary in manufacturing is the character of the raw material. Little of this is standard in quality or quantity and an expensive and thorough process of editing must be performed before it can be properly said that manufacturing commences.

It is evident, therefore, that this particular manufacturing process from the viewpoint of the engineer must contain the added element of time. Many of the problems encountered are similar to those of the power plant in regard to duplication of units and excessive facilities in order to insure production on time. Any design of a plant must therefore take account of these requirements and save all the time it can by means of direct routing of successive steps.

There are four main operations in the process of manufacturing a newspaper as follows:

Editorial Functions
- Obtaining news
- Making, preparation and manipulation of copy (the raw material).

Composing
- Production of type
- Photo Engraving
- Preparation of advertisements
- Handling and composing of pages

Stereotyping
- Moulding
- Production of Printing Plates

Press Work
- Actual Printing on paper

Engineering is not directly involved in the first step except as applied to the general business of communication by telegraph, telephone and radio, all newspapers being large users of these systems. Much has been accomplished in the development recently of the teletypewriter or automatic typewriter electrically operated by a master machine from a central point. Newspapers have also availed themselves of the transmission of photographs by both telephone circuits and radio wave.

Linotype Emancipated Newspapers

The second step is the first actual manufacturing process involved and consists of the conversion of printed or written copy into type and the subsequent assembly of the type into forms or patterns of the printed page. No description of this step can fail to mention the Mergenthaler line of type "Linotype" casting machine. This machine emancipated the industry from the great manual labor of setting type piece by piece and the machine as an example of engineering is probably second to none in existence. It has given great impetus to the printing industry as a whole in the writer's opinion and was the first application of engineering to what had previously been a handicraft. The modern newspaper in any city in the United States will employ numbers of these machines in order to produce the necessary quantity and quality of type in time to meet their edition schedules. The Linotype machine produces, as its name implies, a line of type of predetermined length; such "slugs" then being assembled to make the completed "story". Numbers of these stories are then assembled in a steel form on a flat table, each form making one entire page of the newspaper. During the time of this assembly the story is proof read and, if necessary, corrected by recasting in the linotype machine that slug which contains the error. In the case of photographs, drawings or graphic representations the photo engraving process has supplied the printing industry with the necessary media with which to print. This process and its similar ones, electrotyping and flat stereotyping are properly adjuncts to the composing or second step. Many tons of type metal (an alloy of tin, antimony and lead) are melted and remelted in this process and the depreciation and alteration of this soft metal alloy has been greatly reduced by the recent application of electric resistance heaters immersed directly in the metal. The present day composing room is operated entirely by electricity where five years ago much of the metal melting was performed by gas. This improvement has been due principally to the more accurate control of temperature that is possible with electricity. The application of engineering to this step in manufacture is to obtain the most economical sequence of operation and the layout of machinery and apparatus is of paramount importance.

The third step in the process is known as stereo-

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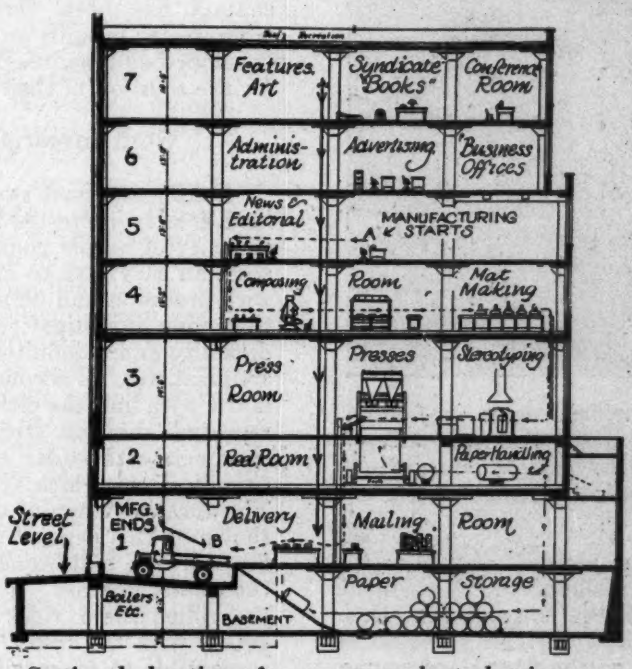

Sectional elevation of newspaper plant showing arrangement of gravity system. Presses are on the fourth floor to facilitate speedy distribution of newspapers.

Textile Research at the Institute

BY PROFESSOR GEORGE B. HAVEN

In Charge of Textile Research, M. I. T.

THE expanding uses of textile materials in the manufacture of the automobile and aircraft, together with the numerous novel forms of fibers employed in the construction of machinery in general, has brought to the door of the Institute a great number of research questions. A fabric base long since adopted for belts, tires, wings and gas-bags, has called for wide experimentation and the determination of many new properties and attributes. It is of

A machine for producing artificial wear in fabrics. A strip of cloth is repeatedly rubbed against a piece of 000 emery cloth and the amount of wear measured by loss of weight or tensile strength.

the utmost necessity that the physical as well as the chemical characteristics of the fibers employed should be accurately known and measured, and that their varying strength, elasticity and durability should be carefully investigated. The cotton fiber is, of course, the preeminent material for the fabric base, and as such, when vulcanized into a wide variety of rubber goods, forms the item of strength in such materials.

The Institute has long been a leader in textile experimentation and research. In 1917 Yeaton and Panettier plotted the first experimental curve indicating the characteristics of automobile tire canvas under varying absorptions of atmospheric moisture. This plot has since become the nation-wide basis of moisture correction in the tire and canvas industry.

With the advent of the tire cord, the researches of Kurriss and Leslie in 1923 established the same relationship for this class of material. These determinations have been of great value to the tire industry throughout the country.

The Institute Textile Laboratory was one of the earliest in the country to recognize and rate the elasticity of textile materials. At the present time, practically all industrial laboratories consider the measurement of stretch in textiles fully as important as any other physical property. Under the direction of the Staff, many unique and original machines and methods have been perfected for measuring the porosity of textile materials to air and water, the relative and absolute absorbability of toweling, and the insulating properties of blankets and clothing, as well as many devices for measuring and improving the manufactured forms of textile goods.

As a direct means of contact with the textile industry, the Institute has recently inaugurated a series of short-session intensive courses in textile research. These are open to laboratory directors, research engineers and others closely identified with manufacturing processes. In this manner, during the past two years over fifty leading textile experts from all portions of the industry have come to the Institute and gained acquaintance with the methods and apparatus especially used in textile research. The reaction from this contact has been very gratifying. Many private laboratories in mills and other industrial plants have developed and manufactured the Institute's apparatus for the solution of their own specific problems.

Staff Investigates Textile Wear

During the past twelve years the textile staff has been greatly interested in investigations of the wearing capacity of textile goods. At first thought, it would seem an easy task to measure and rate artificial wear with precision and definiteness. As a matter of fact, this wide investigation is accompanied with much difficulty and indefiniteness. The attempt to produce artificial wear is accompanied by the clogging of the fabric with lint, the ultimate glazing of the same under repeated abrasion strokes, and the charging of the specimen with static electricity. These items cause complications which are not at all easy to dispose of. The abrasion machine devised by the Institute Staff is shown on this page. A strip of the fabric under test is flexed over a ball-borne roller of small diameter many thousands of times. Upon the fabric as it passes over the roller there rides a "rubber". The latter together with the roller, must be made of a metal not susceptible to magnetism. The rubber must be clad with a standard abradant, such as a perfectly flat piece of 000 emery cloth. As the fabric is drawn back and forth over the roller, the emery particles cause a uniform degree of abrasion. The rubber, however, must

be free to oscillate through a small angle, so that the lint particles will be expelled into the air at each reversal and will neither clog the abradant nor collect upon the fabric. In the above manner a uniform degree of artificial wear may be imparted to a fabric specimen. In many types of cloth the reduced tensile strength, after abrasion, is a sufficient measure of the effects of wear. In other fabrics, such as felts, blankets, plushes and upholstery materials, the effects of wear have to be rated by the loss in thickness and in weight, and the increased porosity of the fabric to the passage of air. The latter properties are at present under investigation. It is interesting to note that over twenty-five of the leading laboratories in the United States have applied to the Institute for blue-prints of this machine and have constructed the same for use in their own investigations. Many industrial plants have made prolonged studies of the behavior of different weaves and cloth formations under artificial wear. Such researches direct the manufacturer how to make his fabrics more resistant to wear and how best to conserve their clothing value.

Within recent years many new uses have been found for artificial fibers of extruded cellulose known as "rayon". These fabrics are widely known for their luster and beauty as well as their vivid coloring effects. In 1925 Mason and Miller determined the full effects of atmospheric moisture upon rayon yarns of the regenerated cellulose type, and in the following years Messrs. Thompson and Peck made the same analysis for acetate rayons. Their figures have been widely used as a basis for standard moisture regain of these fibers and for adjustments in buying and selling rayon materials by weight.

Machine Tests Rayon Yarns

In determining the excellence of these artificial fibers, it is of the utmost necessity to maintain standard atmospheric conditions in order to obtain accurate and comparable results. The above experimenters were the first to our knowledge to plot the relation of moisture absorbed from the atmosphere to the strength of rayon products. The latest accession in textile research in the matter of laboratory equipment. is shown. This machine is especially adapted for determining the strength and elastic properties of single strands of rayon yarns. Its capacities are 500 and 1000 grams. It is built with a very delicate electric recorder so that the stress-strain diagram of the rayon may be recorded directly by the machine.

It has long been held that artificial fibers such as rayon exhibit the full phenomenom of elasticity limit and yield point. It is yet a contested question whether such is a definite elastic limit, as understood in materials and other substances, or is an incipient breakage of the individual filaments in a strand of rayon yarn. This subject is at present under investigation. Whichever it is, the location of its exact value is of much importance to the rayon industry, since fabrics and yarn, stressed beyond the apparent elastic limit, will suffer permanent distention and will probably be in the early stages of physical breakdown. The apparatus illustrated on the right is built with the utmost precision and constitutes a machine of many possibilities in the study of fine yarns.

Within recent years the Textile Laboratory has been developed in the direction of Microscopy at the hands of Professor E. R. Schwarz. The equipment in

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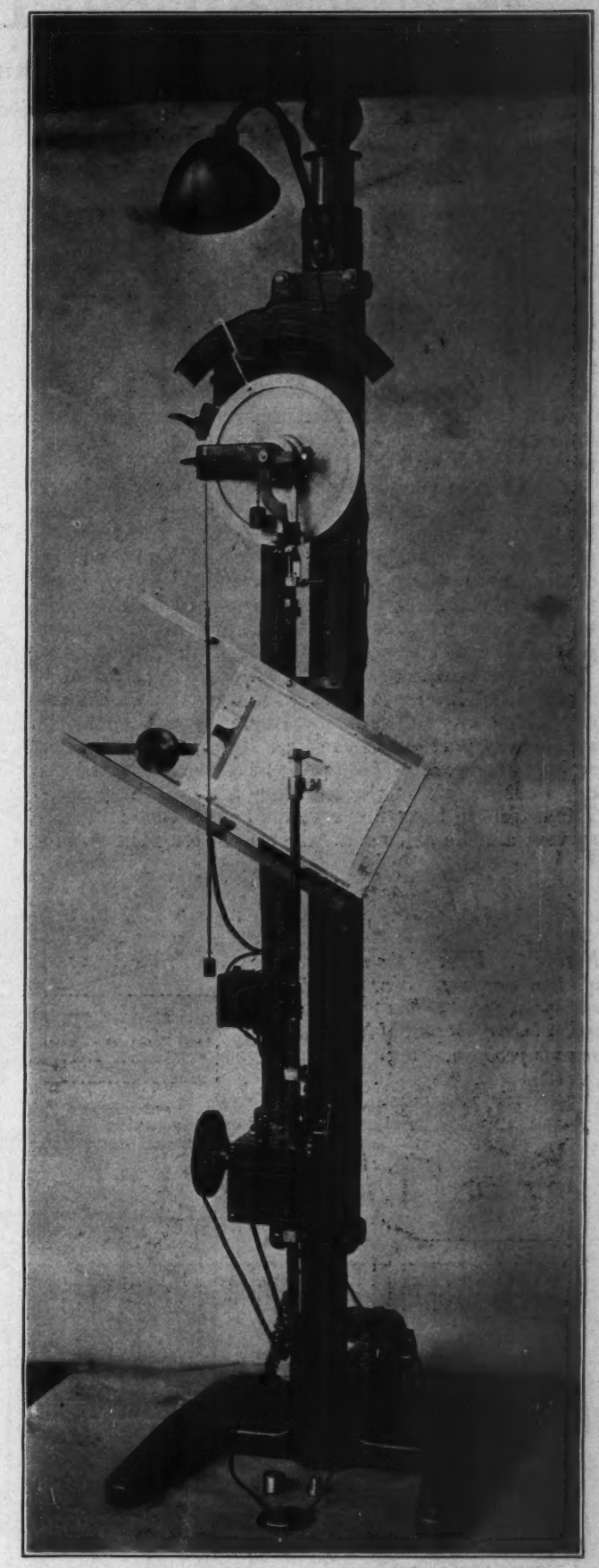

One of the latest accessions in the line of textile laboratory equipment. The machine is used for determining the strength and elastic properties of single strands of rayon yarns and results are recorded automatically.

Sewage Treatment

BY RICHARD H. GOULD

Department of Sanitation, New York City

BIDS were received on March 9, 1931 for the first contract for the construction of a sewage treatment works on Wards Island in New York City. The plant is to be of the activated sludge type and is to have a capacity to treat a flow of 180 million gallons per day of sewage. This corresponds roughly to about 20% of the present total flow of the city. There are now some eight plants of the fine screening type in operation throughout the city treating in all about 10% of the total flow. The Wards Island Works, therefore, represent the most important step yet taken in clearing up the sewage pollution of New York Harbor.

The Wards Island Project is to receive the drainage to the Harlem and part of the East River from Manhattan and the Bronx. In the first construction program the intercepting sewers in the Bronx will be extended only as far as Jerome Avenue. Later, upon the enlargement of the plant, they will be extended to serve a much greater area and possibly to pick up part of the discharges from the Borough of Queens.

The general scheme proposed consists in the construction of intercepting sewers along the waterfront of Manhattan and the Bronx, bordering on the Harlem and nearby portions of the East River, through which sewage and storm water up to the amount of twice the dry weather flow of the tributary area will be passed. The sewers in the tributary area are on the combined system and lie at such an elevation along the waterfront that tide gates will be necessary to prevent the back-flow of the harbor water to the intercepting sewers. The interceptors will lead to a coarse screening and grit chamber in each borough for the removal of heavy grit and material that might obstruct the pumps. From here, deep lying tunnels in rock will lead to a pumping station on Wards Island. The general layout of the works is shown in Figure 1.

Pumps Lift Sewage 45 Feet

The pumps on Wards Island will lift the sewage some 45 feet to the preliminary settling tanks. These tanks, eight in number, are to be of the mechanically cleaned type and provide for a detention period of about one hour. Flows up to 15 times the average dry weather flow will be passed to the aerating tanks and excess flow at times of storms up to two times the dry weather flow will be passed through the preliminary tanks, the surplus not passing to the aerating tanks being discharged to the river through an overflow conduit.

The aerating tanks are 16 in number and are of such a capacity as to provide an aerating period with one tank out of service of 5.25 hours at the average flow of 180 million gallons per day, plus 25%

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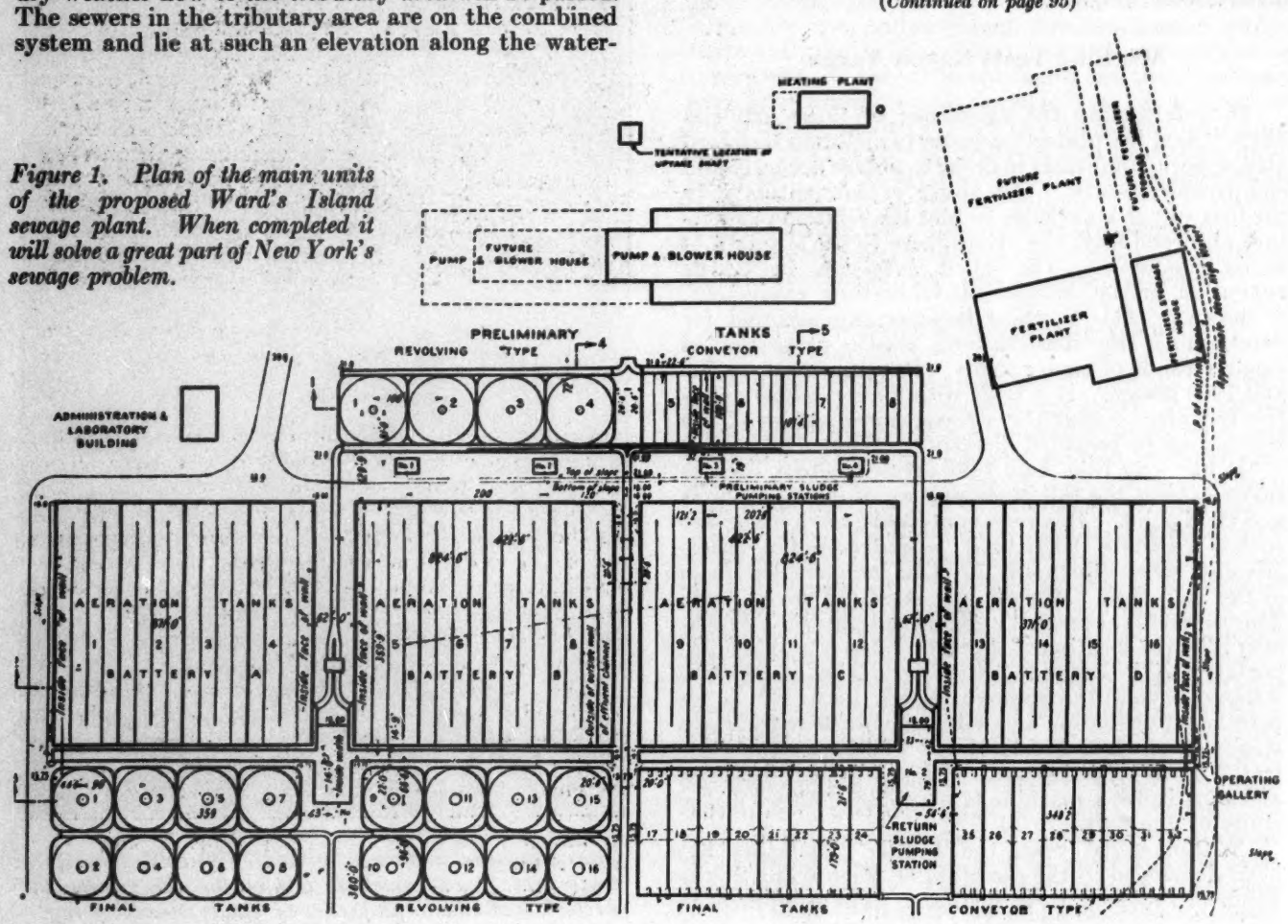


Figure 1. Plan of the main units of the proposed Ward's Island sewage plant. When completed it will solve a great part of New York's sewage problem.

Building the Chicago Exposition

BY C. W. FARRIER

Assistant Director of Works, "A Century of Progress" with S. C. Westerfield '31

DESIGNING a group of buildings for a World's Fair offers for solution a problem which is entirely out of the ordinary run of building problems. Buildings are usually constructed to have a useful life of thirty or more years. Their cost is amortizeable over that period. Buildings built for a World's Fair have a useful life of but a few months. Their cost must be retired in that short period.

Rigid economy in both labor and materials is necessary when designing these temporary structures. It is not possible to reduce the cost of building labor no matter how the building is designed. The only economy that can be made by reducing labor costs is to reduce the amount of field labor involved in the structures. Shop labor, as a general thing, is more efficiently employed than is field labor. In designing economical structures, materials should be chosen which require least field labor. Materials should be processed as far as possible in the shop.

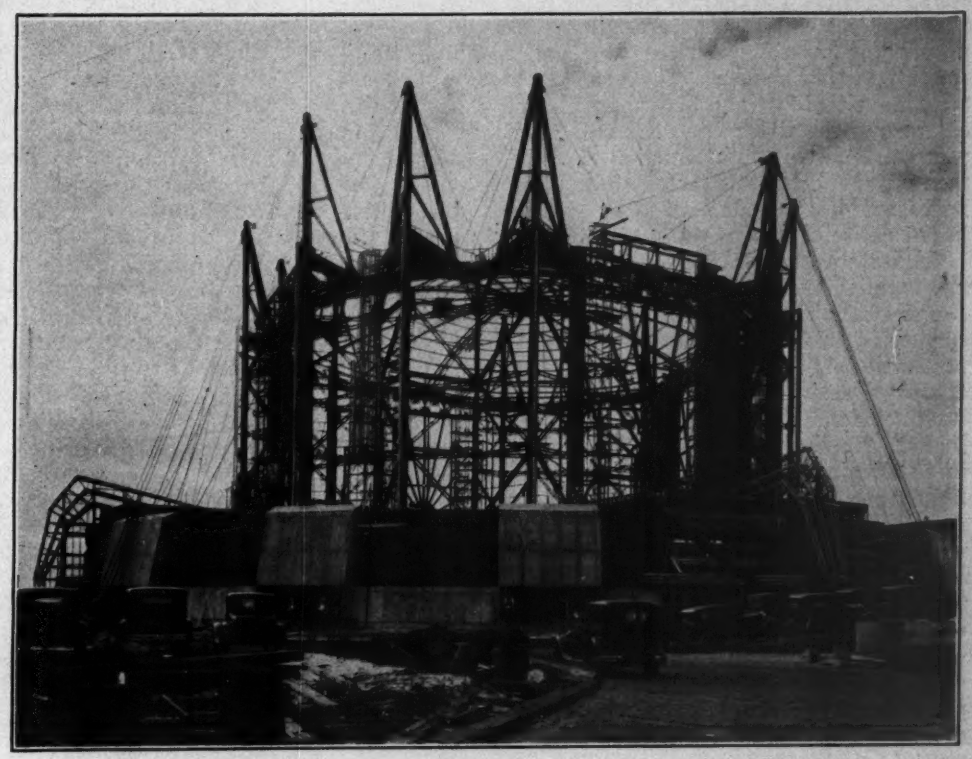
Materials which are light in weight require less field labor for fabrication into the building. Light materials entering into a structure make possible the use of a lighter structural frame.

Suspended Roof

This desire for a light economical structure led to the development and use of the "suspension roof." The buildings required to house the Travel and Transport Show called for a circular structure three hundred feet in diameter containing a space two hundred feet in diameter free from columns.

The construction of this structure along established engineering lines would involve large heavy trusses which require considerable field fabrication. To eliminate a large percentage of this weight as well as to give a distinctive appearance to the structure it was decided to support most of the roof load by means of cables suspended from towers encircling the structure.

The theory involved is the same as that employed in the construction of a suspension bridge. The cables all extend diametrically across the roof and converge towards the center of the dome. The dome is connected to the cables by means of hangers much in the manner that the floor of a suspension bridge is connected to the cables. The accompanying photograph shows the convergence of the cables towards the center as well as the method of supporting the dome.



View showing construction of the suspended roof on the Transportation Building. The roof hangs from cables supported by the columns, three of which appear in the left foreground.

The cables are supported by a combination tower and column, the top of which has the appearance of the tripod of a surveying instrument and gives the effect of a triangular support. These "tower-columns" transmit all the load not carried by the cables to the foundations, thus eliminating the need for further columns. The bases of these "tower columns" have but a single support, the legs of the column again converging to give another triangular support. Except for the base and cable support the "legs" of the column are parallel and together form an angle of 90° giving the effect of two vertical trusses at right angles and having a simultaneous bottom chord.

There are twelve of these tower-columns supporting the dome. Four of the cables are anchored in a bed of concrete 30 x 30 x 11 feet deep while the remaining eight are anchored in blocks 21 x 30 x 11 feet deep. The cables are tied in to these blocks by half of a 21-inch I beam. Due to the large circumference of this dome it contains six expansion joints.

The exterior of the Transportation Building is composed of metal sheeting that is literally hooked to the steel superstructure. This is accomplished by drilling holes in the back of the sheeting into which is attached a hook which in turn is clamped to the superstructure. This is but one of the special features employed in the fabrication of buildings having a very limited life.

Higher working stresses could be used in the design

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Case-Hardening with Ammonia Gas

BY V. O. HOMERBERG '27 AND J. P. WALSTED '29

Department of Mining and Metallurgy, M. I. T.

IT has been the dream of metallurgists for many years to produce a steel of good toughness with maximum surface hardness and wear resistance. To produce these properties with a minimum of distortion has been the subject of much research work of a high order. In the past the most successful method of obtaining these properties has been by subjecting low-carbon steel to the action of a carburizing material at high temperatures. Under these conditions the steel takes up carbon in its surface layer, changing that portion of the material into a high-carbon steel capable of hardening, while the core remains low in carbon with the usual toughness and shock-resisting properties. By a suitable double heat-treatment the core can be brought to maximum physical properties while the case can be made hard and wear-resistant. This process of case-hardening by means of carbon is somewhat cumbersome. The necessary heat-treatment after carburizing is a frequent cause of distortion of the hardened parts.

A new process of case-hardening has been developed which has all the advantages of the older method. Besides being free from the troublesome warpage it surpasses the older method in the hardness of the case produced. The classic research of Doctor Fry at the Krupp Works, Essen, Germany, is responsible for the introduction of this valuable metallurgical development. Research of a very high order in France and in this country has brought the process to its present high state of development.

The investigation conducted by Dr. Fry began with a consideration of the combining power of various alloying elements toward nitrogen and the stability of the resulting nitrides. He found that aluminum ranked first, both as to the amount of nitrogen with which it combined as well as the stability of the aluminum nitride formed. This compound showed no loss in nitrogen even when heated at 1832° F. Other elements which formed nitrides with high nitrogen contents include chromium, vanadium, titanium, tungsten, molybdenum and manganese.

Steels Exposed to Ammonia Action

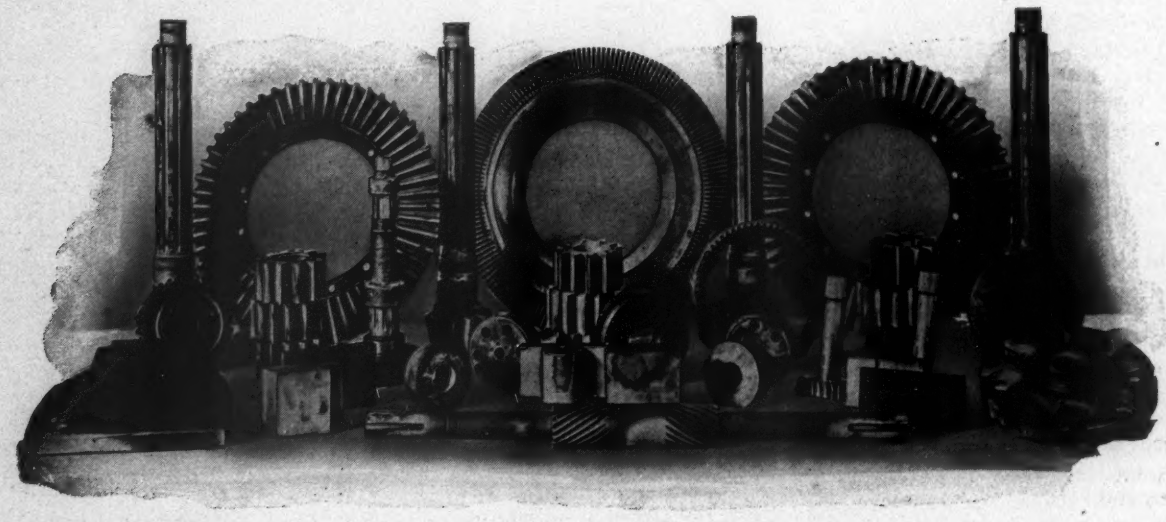
Plain carbon steels, various alloy steels, including those containing aluminum and aluminum together with various other elements such as chromium and molybdenum, were subjected to the action of ammonia gas under definite conditions and the resulting surface hardness was determined in each instance. The outcome of this investigation was the manufacture of a series of alloy steels containing varying amounts of carbon, together with approximately 1-1.25% aluminum, 1-1.5% chromium and 0.2% molydbenum. Alloy steels having this particular combination of alloying elements were chosen because they showed the maximum surface hardness when exposed to ammonia gas under definite conditions. Furthermore, this hardness was retained at elevated temperatures and the specimens showed a marked resistance to atmospheric, water and salt water corrosion.

The process of case-hardening these steels with ammonia gas at the low temperatures designated by Dr. Fry is termed "nitriding." The temperatures used generally range from 900° F. to 1000° F., 975° F. being the most common.

The Fry process for case-hardening with ammonia offers many decided advantages in that all of the heat treating of the articles is done before the nitriding and no further treatment is necessary after their exposure to the ammonia gas. The temperature used is so low that no appreciable warping or distortion will take place provided that all of the strains produced in machining and in hardening have been removed.

The articles to be case-hardened should be machined and then heat-treated to give the desired physical properties for the core. All traces of decarburization and all strains must be eliminated before the subjection of the articles to the ammonia treatment.

The equipment required for the case-hardening of articles with ammonia consists of a suitable furnace provided with automatic temperature control, an air-tight container, which should be made of a material



Examples of larger wearing parts which have been made of nitrided steel. The life of such parts is markedly increased by the use of such steel.

not susceptible to nitride hardening, a tank of ammonia provided with a suitable needle valve for controlling the flow of the gas and finally, a special pipette for determining the extent of the ammonia dissociation.

The diagram gives a schematic outline of the required apparatus. The tank of ammonia must be placed in a position such that the bent tube inside of the tank has

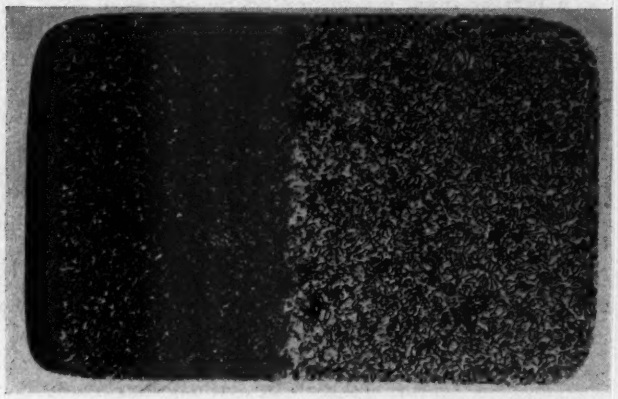


Photo-micrograph of a cross-section of nitrided steel showing penetration of the hardening action of ammonia gas. Enlarged fifty diameters.

its open end in the gaseous atmosphere and does not dip into the liquid ammonia. A suitable needle valve together with a pressure gage insures the control of a steady and even flow of the gas. Although anhydrous ammonia is a commercial product, the final traces of water can be removed, if so desired, by passing the gas through a tower containing lime. The inlet and the outlet tubes are made of nickel and the articles in the box are supported on nickel gauze. The inlet tube extends along the bottom of the box to the back while the outlet tube is at the front and near the top of the box. Pyrometers are inserted into both the container and the furnace. The gas mixture from the container passes through a wash bottle to indicate the back pressure, which should be about one-half-inch, as well as the rate of flow of the gas, and finally passes into the atmosphere or is washed into the drain in the sink by means of a suitable baffle.

An important development in a nitriding furnace makes use of a fan to effect gas circulation.

Ammonia Gas Partly Decomposed

Ammonia gas decomposes to a certain extent into nitrogen and hydrogen. The nitrogen, which is very active at the moment of the decomposition of the gas, combines to a certain extent with the alloying elements in the steel to form nitrides. These nitrides, which are in solid solution or in a fine state of dispersion in the case, impart extreme hardness to the surface of the steel, a hardness which gradually decreases inwardly until it corresponds to that of the core.

The gas mixture leaving the furnace consists of hydrogen, nitrogen and undissociated ammonia. The ammonia gas is very soluble in water whereas the hydrogen and the nitrogen are insoluble. Advantage is taken of this fact in the determination of the extent of the ammonia dissociation during the nitriding operation. The special pipette is used for making this determination.

The time of exposure of the articles to the action of the ammonia gas at the nitriding temperature varies from 2 to 90 hours, depending on the service to which the articles are to be subjected. No heat treatment is given to the parts after nitriding, the articles being cooled in the box, generally to room temperature.

A slight growth takes place during nitriding. This growth can be allowed for in the final machining or grinding before nitriding, or it can be removed afterwards by lapping or by other suitable means.

A greater surface hardness can be obtained by this method of case-hardening than by any other means. The common method of case-hardening produces a surface hardness of 650 Brinell, whereas a hardness of 1000 Brinell is common with the Fry process.

Another valuable property which accompanies the extreme surface hardness of nitrided nitralloy is the resistance to atmospheric, water and salt water corrosion. The maximum resistance to corrosion is exhibited by the unpolished surface. In view of this fact, it is preferable to place nitrided articles directly into service without additional polishing whenever the question of corrosion is involved. It is obvious that this property of rustlessness together with extreme surface hardness renders nitrided articles highly desirable for a great many purposes.

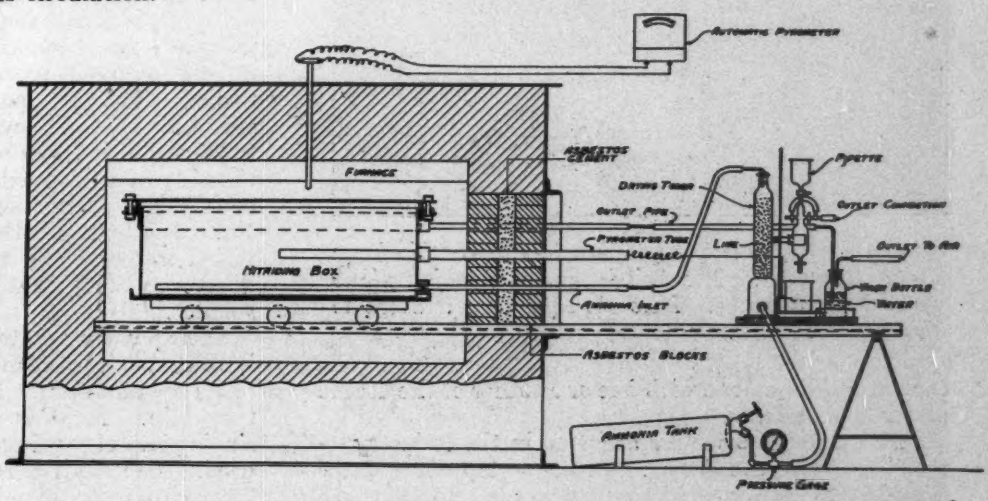
Nitrided steel retains great hardness at elevated temperatures. It shows practically the same degree of hardness when tested at 1000° F. as at room temperature and shows an excellent degree of hardness when tested at 1400° F.

The use of nitrided steel in various commercial operations has fully demonstrated its great wearing properties. Many instances of actual service tests might be mentioned.

Guillet* has studied the wearing properties of nitrided steel especially with respect to the automotive industry. Some of the data presented by him are included in the following table:

(*Continued on page 101*)

*Lecture to Academy of Sciences in Paris, France.



Drawing of interior of nitriding furnace. The parts are run in on a conveyor and exposed to the action of ammonia gas for a period of time depending on the hardness desired.

Portland Cement Manufacture

BY A. J. R. CUXTIS

Assistant General Manager, Portland Cement Association

FUNDAMENTALLY, Portland cement is a highly manufactured product, containing approximately 60 to 65% lime, 20 to 25% silica, and 6 to 14% iron oxide and alumina with small percentages of other materials. Different raw materials such as calcium carbonate and silicates of aluminum provide these substances in various combinations.

Manufacturing processes differ slightly according to the natural state in which the raw materials are found. Some of the combinations used in different plants in the United States include; cement rock with limestone or clay, limestone with clay, limestone with shale, marl with clay, chalk with clay, limestone with slag, oyster shells with clay. In some localities deposits of cement rock are found which require little or no additional materials, but the majority of plants mix the natural limestone with one or another of the usable materials available.

Quarried rock is crushed to usable size in this large gyratory crusher. The unit is capable of taking pieces the size of a piano. Note the safety line attached to the worker's waist.

Two general processes are used in the industry — the "wet" and the "dry". In the wet process water is added to the crushed raw materials and they are handled from then on in the form of a thin mud which is pumped from machine to machine. The machinery used for both processes is essentially the same so that this discussion of the dry method is also illustrative of the wet.

A terrific blast accompanied by clouds of dust and falling rock is the usual beginning of modern Portland cement making. In this way some 23,000,000 pounds of explosives are used each year. An unusual blast is reported wherein 400,000 tons of rock were moved at one charge, but charges that displace 50,000 tons of rock at a time are not uncommon. Thirty years ago the cement industry consumed daily about 700 tons of rock. Today the average plant requires more than that for a single day's run.

When the dislodged rock has settled back into the quarry, steam shovels capable of lifting several tons at a time load it into cars for its trip to the mill.

Blasted Rock Crushed

Arriving at the mill, the rock is dumped directly from the quarry cars into the gyratory crusher where it receives its first grinding. This crusher, capable of reducing rocks the size of a piano, is somewhat in the shape of an inverted bell with an upright clapper. The rotary movement of the clapper crushes the rock into smaller, but still coarse, sizes and performs at the rate of 1000 tons an hour. The rock is then moved by bucket conveyors to the hammer mill where its size is further reduced by the action of revolving steel hammers. On completion of this secondary grinding it is passed on to storage bins to await further treatment.

Taken either from storage or direct from the hammer mill, the raw materials are thoroughly dried in large heated revolving drums before being placed in the blending bins. At the blending bins the two kinds of raw material — limestone and clay or shale, or whatever other material is being used — are carefully proportioned by expert chemists who set the automatic scales to give the desired mixture.

The raw materials, properly proportioned, then pass to a battery of ball mills to undergo the first stage of fine grinding. Nearly all forms of present-day grinding machinery use the principle of pounding the material between some form of metal hammer and another form of metal mass. A ball mill is a horizontal steel cylinder, six to eight feet in diameter and four to six feet in length, partially filled with large and small steel balls. As the cylinder revolves, making from 23 to 25 revolutions per minute, these balls are carried up the side and dropped back to the bottom and upon each other, pulverizing the materials as they fall. From the ball mill the materials enter the tube mill which is essentially the same in principle, the only difference being that it is longer and the balls are smaller.

The powdery material emerging from the tube mill is now ready for the most important step in the process of its manufacture. It is about to be fired in the rotary kiln. For this step in the process the largest single piece of moving machinery known to industry is used. The modern rotary kiln varies in length from 150 to 375 feet and measures from 8 to 13 feet in diameter. A moderate sized kiln is 200 feet in length with a diameter of 10 feet. These kilns are supported on roller bearings and make about three-fourths of a

revolution per minute. They rest in an inclined horizontal position, the materials entering the higher end. Into the lower end there is blown a jet of flame, fed by pulverized coal, fuel oil, or gas, which creates a heat of from 2500 to 3000° F., a temperature actually much hotter than that of a volcano. Were it not for the thick fire brick lining the heat would melt the steel shell of the kiln itself. This fiery tongue extends 30 feet into the kiln.

Heat Causes Chemical Changes

The powdery mass moves slowly along propelled by the rotary action of the kiln. Soon the raw materials are relieved of all moisture. Next the carbon dioxide is driven from the limestone. Nearing the hottest zone of the kiln the materials approach incipient fusion. It is at this moment that the chemical and physical changes take place which give the product its cementing qualities. Just short of being liquid the new material forms into small, white hot balls, varying from one-quarter to three-quarters of an inch in diameter.

These dark-colored, glass-hard pieces coming from the kiln are called cement clinker. This clinker is practically unaffected by moisture, but as soon as it is pulverized it assumes the property of hardening when water is added.

This clinkering, as the burning in the kiln is called, is a very delicate process and requires great care in the regulation of temperature. Experienced operators, wearing colored glasses, watch the interior of the kiln and closely follow the process.

Leaving the kiln, the clinker is passed through long cylindrical coolers and then either placed in storage or sent directly to another battery of pulverizing mills. Extreme fineness of grinding is essential to produce good cement, both before and after burning. The chemical laboratory maintained by all plants makes tests throughout the process and subjects the final product to a very rigid examination.

Before the cement clinker enters the tube mill for its final grinding, a small amount of gypsum, from two to three per cent by weight, is added to regulate the hardening of the cement when it is used. Without this addition, the ground clinker, when mixed with water, would harden in a few minutes, like plaster of Paris, and would not permit time for moulding or casting into the desired shapes.

The final grinding is interesting. The little ball-shaped clinkers, tougher than glass, are inert and may be stored indefinitely in open weather with little or no chemical change; but when ground to a fine powder they result in a substance that is highly active and when combined with water in the correct amount, become enduring artificial stone. Machines for pulverizing the clinker are similar to those used for grinding the raw materials. As in the first case, there are two stages, the preliminary and the final grinding. The centrifugal mill, to which the clinker is first submitted, is a vertical drum equipped with two steel rollers which revolve around a steel post in the center of the mill. As the clinker is crushed between the rollers and the sides of the mill it is ground to about the size of sand grains.

Screens Have 40,000 Holes Per Square Inch

The cement is now fed to the tube mill which is similar to the one used in pulverizing the raw materials. The steel balls continue to pound and pulverize the cement until, in accordance with standard specifications, 78% of the tube mill product will pass through a screen having 40,000 openings to the square inch, a sieve capable of holding water.

Now the finished Portland cement is ready for sacking. In the earlier days of the industry sacking was done by hand. Workman then measured out the cement carefully, using scoops and scales as each sack of cement must weigh just 94 pounds. To the user of cement this means that every sack contains one cubic foot of cement. However, this hand-weighing and filling method was slow. After being filled the sacks had to be tied, In modern sacking the cart has actually been put before the horse. The sacks are tied before filling. Machines automatically allow just 94 pounds to go into the sack, the cement being forced through a self-closing valve at the bottom of the sack. The operator then tips the sack onto an endless belt that carries it away to the shipping room.

Thus is Portland cement made. In the process there are some 80 distinct mechanical operations required. Over 200 pounds of raw material, one-quarter of which is coal, is needed for each 100 pounds of finished product. The industry ranks among the highest in total horse power required to operate its grinding and other machinery. The power equipment installed in a single large cement plant produces enough electricity to supply a city of 150,000 popula-

(Continued on page 94)

Interior of tube mill. The clinker is introduced amongst various sized steel balls which grind it to a fine powder as the mill revolves.

Corrosion and Heat Resisting Steels

BY F. J. McNIFF

Sales Engineering Department, Industrial Steels, Inc.

THE aim of this article is not to present a technical discussion of the many phases of the above subject, but rather to collect and clarify the outstanding facts which have a bearing on the manufacture and ultimate use of such alloys. To properly appreciate the value of these steels, it might be well to recall to mind the fact that 25% of the world's tonnage of iron and steel is lost by rust every year. Stainless steel is playing an active part in the fight to reduce the appalling losses due to rust and corrosion.

The first phase of the problem to consider is the importance of chromium. The effect which this alloy has on retarding corrosion has been known for years, and recently much study was made of the effect of the associated carbon content. The result has been the production of the present types of stainless steel and iron. Chromium is the most valuable element now used in the production of alloy steel, due to its diversified properties. It is obtainable in large quantities from many sections of the globe, in such quantities in fact, that in the event of another upheaval such as the World War, it would not be necessary for any country to curtail its use.

Due to a clear understanding of its properties, it is now possible to produce a number of corrosion resisting alloys with which almost any required degree of hardness and strength can be obtained, as well as various combinations of toughness and elasticity. They are sufficiently resistant to such a wide range of corroding media as to be of inestimable value for engineering purposes.

It might be well, before going further, to clear up a very widespread misunderstanding of the terms "stainless steel" and "stainless iron." The terms steel and iron are generally considered to mean those ferrous materials that are capable or are not capable of being affected by heat treatment. Since stainless metals with as low as .07% carbon can be heat treated with considerable change in physical properties it will be plainly seen that "Stainless steel" and "Stainless iron" are misnomers. It would seem wiser, therefore, when investigating the possibilities of the stainless metals, to specify chemical compositions rather than the general terms commonly used.

In choosing the proper type of stainless for a particular application the problem should be approached with a full knowledge of all of the factors entering into this application. The exact nature of the corroding agent, the temperature if above normal, whether the action is continuous or intermittent, the manner in which the metal is to be fabricated, and whether or not the material is to be welded, brazed, soldered etc., are all questions of vital interest if the maximum efficiency is to be obtained.

The characteristics of the various types, which will be shown in following paragraphs, will demonstrate how necessary it is to use the right metal for each particular use.

Another factor of prime importance in selecting the proper metal is the fact that the stainless metals are the most difficult to produce satisfactorily, and, more than any other steel, reflect the care and workmanship and general steel making ability of the manufacturer. Experience has shown stainless to be the most susceptible to internal segregation, non-metallic inclusions, and surface seams of any alloy steel.

Types

The stainless metals may be roughly divided into six different types, as follows: Stainless Steel, Stainless Iron, Free Cutting Stainless Iron, 18 and 8 Chrome-Nickel, Chrome Iron and Special Heat-resisting.

The distinction between Stainless Iron and Free Cutting Stainless Iron is made because of some problems in connection with hardness and physical properties, which will be discussed in more detail in later paragraphs.

The type generally known as Stainless Steel was first adopted for use in cutlery, and this is perhaps its largest application, although it has been used to some extent in valves for automobile engines. It is an air-hardening alloy used where resistance to corrosion plus a high degree of hardness and resistance to abrasion is required. It is somewhat lacking in toughness and ductility but is very hard at temperatures up to 950°-1000° F.

The approximate chemical composition of stainless steel is as follows: chromium 13.00 — 20.00%, carbon .30 — .65 or .65 — 1.5%.

Being air-hardening, the steel must be annealed after forging if machine work is required. In all heating operations, it is necessary to preheat and hold longer at temperature than ordinary steel. Frequent reheating is advised when forging. Oil quenching is recommended for all of the stainless steels, although very light sections may be quenched in an air blast, with slight sacrifice of hardness. Great care must be taken with the grinding of this material; it must be deep and thorough, and all traces of scale must be removed.

With the higher carbon types of stainless steel, slightly higher annealing and hardening heats must be used. Annealing should be done at 1625 to 1675° F., and hardening at 1875 to 1925° F. This will result in slightly higher Brinell hardness values.

Stainless Iron

Material of this type is generally used for applications requiring good corrosion resistance, high tensile strength and toughness coupled with ductility. It can be hardened by suitable heat treatment, and is fairly strong and scale resistant at temperatures up to 1400° F.

The typical composition of Stainless iron is as follows: Chromium 11.50–13.50%, Carbon under .12%.

Engineers and those familiar with the difficulties presented in consistently obtaining maximum elastic limit in conjunction with a high Izod value will fully appreciate this steel. Its uses are almost unlimited and it is solving many problems, in valves for high temperature and high pressure service, for valve trim and pump linings in the oil refineries, nitric acid handling equipment, and many other applications.

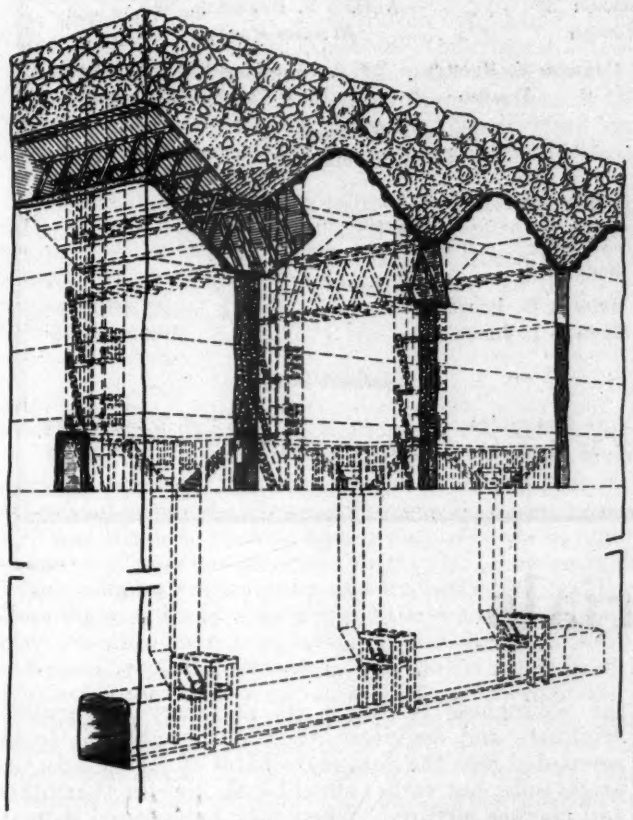
(*Continued on page 102*)

Use of Timber Underground

BY ROBERT S. BACKUS '31

Chairman Combined Professional Societies, M. I. T.

WHEN an opening has been cut beneath the surface of the earth, the rock shows its dissatisfaction in many ways. It may drop pieces down from the roof, it may push up from the bottom, known as heaving, or it may suddenly throw a chunk out from the wall, called rock burst or popping rock. Rock dropped from the roof in small quantities is a menace to the men working as well as the tramming. If a whole section falls, the effect compares with that of a bellows, and instances are on record of men being blown 100 feet or more. If the floor of the mine heaves, all tracks are thrown



Some idea of the immense amounts of timber used underground may be gained from this diagramatic view of the many types of underground support

out of place and haulage has to be discontinued until the repairs are made. The rock bursts may be serious, and do considerable damage. The cause of these is the instantaneous release of the internal stresses within the rock itself. Usually it pulverizes the rock; occasionally a slab comes off the wall or floor. These slabs have been known to exert sufficient force to lift a loaded car off the tracks. In order to avert such action, timber is put in the mine, located at the critical points in an effort to provide safety for men and insure regularity of production.

To deal with this subject with any degree of completeness would require far more space than has been allotted to this article However, by describing the timbering operations of a large mine, it will be possible to give the reader a slight idea of the use of wood and steel beneath the surface.

All types of support may be divided into three main classes, depending on the use to which they are put. The first is the support of the workings themselves, the second is the support of men, and the third class is the support of equipment. In the first we have to deal with the movement of the rock overhead and underfoot. Contrary to the usual conception, this is not to hold up all of the ground between the drift and the surface. Timber is merely used to support those blocks immediately above the top and sides of the opening which tend to loosen and fall during and after the formation of the natural rock arch, and which lie between the arch and the opening. In the second case it is necessary to erect some sort of platform to enable the men to work efficiently and with safety at some distance above the floor of the mine and to give them means of getting their apparatus up to that place. In the last or third class fall the timber in shafts, chutes to direct the ore from the working place to the cars, and support for underground hoisting apparatus.

The type of wood used varies with the part of the world in which the mine is located. Of late, Douglas fir has come rapidly into prominence but large quantities of spruce, pine and hemlock are still found in use. Where abrasion is to be overcome, oak is used but, owing to its excessive weight and cost, this practice is avoided and structures with alternate members of wood and steel are employed. Where stresses greater than wood will ordinarily stand develop, steel "I" beams are used; or in some cases, as in the coal mines of Belgium, masonry and concrete. The size of the timber varies with the use to which it is put. One seldom sees, however, anything smaller than six inch material, the largest size being 12 inches square. This latter is particularly adapted to the support of the roof, or "back" as it is known to the miners.

Situation Demands Great Care

In the case of the mine to be described, the situation is one that demands great care. The rock is naturally fractured in two directions, approximately at 90°, thus causing blocks ranging in size from several pounds to 50 tons to become loosened and drop. In order to avoid accidents, careful inspection is made of the back and blocks that seem loose are immediately either brought down or supported as the case may be. The inspection consists of tapping the roof with a steel bar. As long as there is a ring to the rock, it is assumed to be solid. If it gives the sound of a drum, it is loose and must be dealt with. In the case of very big blocks, this method is not safe for they ring as if they were solid Drops of water on the roof are thought to indicate weakness and are watched for. The work of bringing pieces of "loose" down at the will of the miner is known as scaling. In general, wedges are worked in and the block is pried loose and falls when the miners are ready for it. Occasionally this can be done, but since it would often hold up the mining too much, support of some sort must be put in.

In all mines the drifts equipped for haulage are the arteries that must be kept open in order to keep up production. Thus, if a sudden fall of rock should occur in one of these places, it would tie up traffic and the time lost in clearing it would be very expensive for

(*Continued on page 105*)

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Editorials

Valuable Discontent

On every hand happiness and contentment are urged upon one as the most desirable condition of man. Even under adverse circumstances placards remind one to "Keep Smiling" while happiness is paramount in most of the popular songs and literature of the day. In church many pray for "minds always contented with our present condition."

How false this philosophy! Discontent is the motive behind every foot of human progress since the beginning of history; dissatisfaction with the existing order has fathered every change. The young Prince Gautama, discontented in his luxurious and easy existence, became the wandering ascetic, Buddha, and one of the greatest moral forces the world has ever known. Fretting under what he considered the decadence of the Roman Catholic Church, Martin Luther put in motion the changes of the Protestant Reformation. Francis Bacon, dissatisfied with the science of the time, revised it and formulated that mode of scientific thought which colors to this day the mental processes of the investigator.

In these three examples one can discern that very important element, the constructive spirit. Discontent is the means of calling attention to defects, but the willingness to act is its necessary component. Scientists and engineers, therefore, ought not to be persuaded into the dangerous habit of seeing only the bright side, but rather should look first for that other and blacker picture. When they have found it, may they never lack the courage or initiative to act and to act intelligently.

Wanted: Television

The development of television in the field of communication will be hastened by the fact that there is a definite need for it, that it is not just a curious scientific toy. This opportunity lies in its application to radio broadcasting.

There are other uses, to be sure, to which television can and certainly will be put. Chief among these will be its application as an aid to the telephone. But television is somewhat imperfectly fitted for this field. For instance, the privacy of the home, already threatened by the telephone, will be completely shattered when it becomes possible for anybody who so wishes to climb in the window by means of television. It will literally be necessary to dress up to answer the phone. In short, the addition of television to the telephone, although something of an improvement, will

but slightly aid the latter instrument in discharging its primary function of supplying direct communication between two parties.

Broadcasting, on the other hand, has almost directly opposite psychological requirements. In this field it is necessary to convey, not merely information, but mood and atmosphere. Radio has developed a technique of making the audience, by means of sound effects and the words of the actors, able to visualize the supposed scene of action, and even to gain some of the atmosphere of the setting. Yet this is merely a highly-perfected make-shift, as is shown by the small part which plays and acted stories take in broadcasting and by the limited, artificial impression that many of these programs convey.

We must be able to *see* what is going on. Listening to a football-game announcer is a poor substitute for watching the whole scene unfold before one's eyes. How much more would Amos 'n' Andy mean if their arguments could be observed inside the Fresh Air Taxicab office. Of all our faculties, that of vision is the most acute. Consequently, radio broadcasting can never reach perfection until it allows the eye to at least cooperate with the ear.

Thus, when successful television arrives, a ready berth will be awaiting it. And since, to misquote an old saying, "Demand is the mother of Invention," the development of television may be counted on to go ahead that much faster.

Originality

Who was the first man to use a rolling log as a wheel serving to transport a burden? He is one of our unknown heroes, for although his discovery probably came by accident, he was wise enough to apply what he had learned. Many have watched birds in flight, some wishing that they also might fly. Leonardo da Vinci was an original man and studied every detail of the flight of birds. Ever since there have been apple trees people have seen falling apples, but it took the originality of thought of a Newton to draw from a falling apple the conception of a law of gravitation.

History teaches us that it is not always the man who achieves the original in thought who receives the glory and credit for his discovery. What one man realizes for the first time in his mind often remains for another to show to the world at large. Leonardo was sure that flight was possible to man but he was long ages ahead of anyone able to prove his truth. Sometimes the original thoughts come to men not having the ability, position, or even the desire to prove their discoveries. Columbus was not the first to feel that the world was round, but he had the chance to prove it to the skeptics and made the most of it.

How can we achieve this originality? It is not something to be learned from books and no man can set himself up as a teacher of originality. The way to this goal must lie in the way one trains his mind while at school. A study method consisting of the routine following of invariable methods of working type problems is perhaps valuable when dealing with those problems in later life, but it adds little to the possibilities of originality in the individual who uses it. Where possible, problems should be attacked in several ways and with various sets of altered conditions. Another valuable habit is the discussion with others of situations and problems met with in actual life and the comparison of methods used in their solutions.

Staff Election

THE TECH ENGINEERING NEWS announces the election of G. K. Burns '34 to the Editorial Staff.

Announcement

To commemorate the centennial of Michael Faraday's discoveries in the fields of physics and electricity, THE TECH ENGINEERING NEWS announces an electrical issue for the last number of the academic year, to appear in May.

The issue will include a biographical sketch of Michael Faraday, a brief history of the major developments in electricity since 1831, and also articles on electrochemistry, latest developments in vacuum tubes, arc-welding, floodlighting, the thyratron tube, modern electric lighting, turbo-electric ship propulsion, high-speed elevators, and the trolley bus.

Leonardo da Vinci

1452 - 1519

In many-sidedness Leonardo remains unmatched. He is best known as a painter, architect, and sculptor, but he holds his place on Technology's walls because he was one of the greatest engineers of all time. A sketch of this length can throw little light upon the man's brilliant life. Further inquiry must be left to the readers. The greatest interest among engineering students is in his practical side and the best introduction can be made by telling of some of his achievements in engineering. He was ever striving toward the unattainable, trying to reconcile art and science, inspiration and mathematics. Fragments and isolated notes, written from right to left, with reversed characters, leave us a record of many of his works, although not a line of his was printed during his lifetime.

Leonardo preferred to be known as an inventor, and was the greatest pathfinder and observer of his day. He proposed streets in Florence with separate levels for promenade and commercial traffic, planned canal systems which are now actually in use in France and Italy, and built armored tanks for use in war. Some other inventions were the first modern chimneys, self-closing doors, and roasting spits turned by currents of warm air. He designed the first parachute, diving bells, a submarine, the first steam cannon, and flying machines; tried to use steam as a means of propulsion; made gun-powder; constructed a glass oven and a still; built machines for sawing, spinning, shearing, washing, and pottery making; and constructed artesian wells, and all sorts of mills, scales, a concave mirror, and a pendulum.

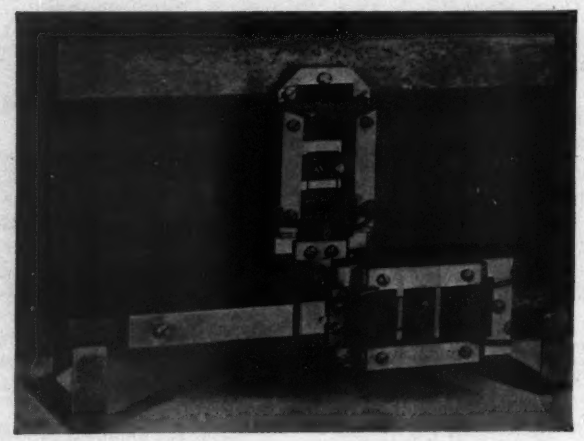
A self-taught man, he began at thirty teaching himself Latin and mathematics. An experience, an empirical experiment, always marked the starting point of Leonardo's dialogues with nature. He observed the accelerated motion of a falling body and found the law two centuries before Newton; constructed the block-and-tackle, and was the first man after Archimedes to record the principles of the lever. This genius founded the science of paleontology by his studies of fossils and stratified rock, stated the principles of gyration andt he vortex, discovered before Galileo the law of virtual velocity, and founded hydrostatics. He understood the undulatory motion of the sea and applied its principles of transmission and reflection to sound and light; measured sound waves and explained the echo and the vibration of overtones four hundred years before Helmholtz and Herts.

Da Vinci, and not Bacon, was the founder of the experimental method. Nevertheless, some of his conclusions were made without apparent proof. He wrote that "The earth is a star, like the moon" fifty years before the book of Copernicus, without explanation or proof. His inevitable notebook went everywhere with him and contained sketches and observations of everything that attracted his attention. He founded comparative anatomy in a series of drawings of bodies which he himself had dissected, explained the eye as a camera obscura, recognized the functions of the lens and of the retina and the mechanics of sight. His discoveries remained unknown for centuries until a revival of the notes showed that he anticipated many men who later received credit for various scientific discoveries and statements of physical principles.

Engineering Notes

Victoria Falls Bridge was built in 1905 with a double track. The loads were calculated to carry a train on each track consisting of two locomotives weighing 1.75 pounds per foot followed by two cars weighing 1.33 pounds per foot. In the course of time, the weight of equipment has increased so that it no longer has that capacity. Consequently, the second track was of little or no value, and it was decided to replace it with one track. At the same time, the cross girders were changed from 12½ foot spacing to 25 foot spacing, relieving the top chord members of the weight of a girder half way between the panel points. The deeper girders necessitated the rasing of the track four feet seven inches. Work was done without interrupting traffic, except for 10 hours a week, on a schedule calling for one new girder a week. The old girders were removed and the new one placed by a locomotive crane. At the same time, a highway was added by installing an overhang on each side.

Cellular Corewalls for embankment dams have been developed on certain irrigation projects in Mexico. These were built to drain off the water seeping through the upstream side of the embankment, and keep the lower half dry. The wall consists of a row of vertical concrete tubes which are connected to each other in sealed expansion joints. They open at the lower end into a large conduit that runs the entire length of the wall. From this conduit, drains placed at intervals lead out below the dam. Any water passing through the upstream side of the cells will be drained off, keeping the downstream embankment dry. In addition, this construction facilitates inspection of the dam at any time. The walls of the cells are curved, thus being better able to support the necessary pressure, and less reinforcing can be used. The amount of concrete used is very little more than in a core wall of the ordinary solid type. The results obtained in cases where this type of wall has been used seem to show that it is quite successful.



Courtesy Westinghouse Electric

The strain gauges are arranged on the rail so that they simultaneously measure the strain in the base and head.

A Magnetic Strain Gauge for determination of strains in beams and rails has come on the market. The gauge is about eight inches long with bolt holes in the two ends. The center section has two coils which carry an electric current. A moving armature is adjustable within narrow limits and the slightest movement of this armature between the pole pieces changes the air gap across which the flux must pass from the two pole pieces to the ends of the armature. The changes in the lengths of the air gaps upset the balance of the voltages across the gauge coils and indicate the degree of strain in the beam or rail at the point to which the gauge is attached.

A Combined Railroad and Road Vehicle, called the "Ro-Railer," has been developed in England. It resembles the ordinary omnibus at first sight. The visible differences are the rail wheels which are inside the rubber-tired wheels, and the couplers and buffers. When on the common road, the two sets of wheels revolve together, having concentric centers. (The rail wheels are smaller.) When on the railroad, the rubber-tired wheels are lifted clear by a set of eccentrics. They do not revolve. The change was made under test in two and one-half minutes, and it is believed that five minutes will be sufficient in service.

The new machine is as good as an omnibus on the road, and when on the railroad possesses the following advantages:

(1) Being protected by the automatic signal and other safety devices and because of the elimination of the danger of skidding, it is safer than any vehicle can be on the road.

(2) Private motorists are not endangered and inconvenienced by it when it is on the railroad.

(3) Cost of fuel is much less, due to greatly reduced resistance.

(4) Comfort is vastly greater than with the ordinary omnibus.

(5) Much higher speed is possible than with any common road vehicle.

It is suggested, in order to make store-door delivery and collection, that freight cars be fitted with this arrangement of wheels. This might be practicable with the cars of England, of 10 to 20 tons, but of course it would be impossible with the 50 to over 100-ton American cars.

Rare Gas Illuminating Tubes, a well-known example of which is the neon advertising sign, will soon be available for use on standard 110 and 220-volt current. A large manufacturer of neon lamps has announced the development of low voltage tubes with a luminosity of as high as 2000 lumens per foot, as compared with the 60 to 132 lumens per foot customary with present high voltage luminous tubes. The new lamps can be constructed to produce light of any given color, including white and daylight. As the light is emitted from a surface much greater in area than the filament of an incandescent lamp, the luminous tube is free from the glare that accompanies the use of the incandescent light.

A further advantage of these rarified-gas tubes is their economy, particularly when colored light is desired. In the case of the neon-filled tube as a source of red-orange light, for example, all the light is concentrated in the red-orange part of the spectrum. It is therefore much more efficient than the incandescent lamp, which produces a yellow-white light that must be filtered in order to get the color desired. To supply blue or green light of a given intensity, a luminous gas tube requires less than one-fifth the power used by an incandescent bulb equipped with a color filter; for red light about one-third as much power, and for white about half the power.

The economy of these rare gas illuminating tubes, coupled with the advantages resulting from their lack

of glare, makes them applicable to commercial and industrial use, particularly where the work involves reading or close inspection.

Fire Hydrants claimed to be a vast improvement on the usual type are being marketed by a prominent manufacturer. This new type incorporates a number of very important features which set the product apart from the rest. A broken barrel may be removed without digging by the simple expedient of using a tubular wrench which engages lugs cast on the base of the barrel allowing it to be unscrewed and removed. The head can be revolved in any direction by simply loosening the bolts in the swivel flange. A low level of drain assures complete drainage of the hydrant, therefore no water remains to cause trouble by freezing or corrosion. The protection case is made of sand-spun cast iron having great strength, toughness, and elasticity. Other fittings are of bronze to prevent rust and the hydrant will not leak when broken, which prevents flooding.

A Gigantic Steel Casting, believed to be the largest ever made in the world, has just been completed in this country. It is made as a cylinder jacket for a 14,000-ton forging press. It measures 12 feet, 10 inches long by 10 feet, 2 inches wide. Six open-hearth furnaces were used in melting the required steel which was deposited in ten minutes through four troughs, one at each end of the mold and two at the side.

The forging press for which the casting was made has been in service since 1893. Before the war, it was used exclusively for armor-plate forging; recently it has turned out heavy forgings for pressure vessels used in oil and chemical industries. Helium tanks for the army and navy have also come from the press which has a capacity of about 12,000 tons annually. Early in December, the old cast iron cylinder jacket made up of several smaller castings cracked and work was immediately started on patterns for a new steel casting. The total job has taken about 10 weeks and 13,000 feet of lumber were required for the patterns. To provide rapid cooling of the molten metal as it came in contact with the mold, two tons of nails were used over the surface of the mold. It was dried by a special pipe and blower system.

Small Mine Locomotives with explosion-tested motors are now being used in many mines. They are claimed to be the smallest in dimension ever built for their weight. They weigh eight tons, are 36 inches high and 11 feet long. Though the top of the frame reaches only to a man's knee, there is a 5-inch clearance above the rails and plenty of room for the operator. The locomotive is armored against the explosive gas common to all mines. They contain newly designed 33 h.p. slow speed motors which are tightly sealed and explosion tested. The wiring is placed in metal ducts except where it enters the equipment through heavy rubber hose and packing glands The most novel feature of these small locomotives is that they are easy riding, the spring suspension including a three point equalizer. This is a distinct advantage since few mine locomotives ride smoothly.

The Largest Earth Dam for electric power purposes has been built on the Saluda River in South Carolina. It is over 200 feet high, almost a mile and a quarter long, a quarter mile thick at its base, and contains approximately 11,000,000 cubic yards of material.

A lake 40 miles long and 15 miles wide at its widest point and covering about 75 square miles with a shoreline of over 500 miles is formed by the dam. The water capacity, slightly less than 100,000,000,000 cubic feet, is the third largest in the country.

Courtesy Engineering News-Record

The locomotive crane is placing a track section. The temporary track elevation is in the foreground.

RAILWAY ELECTRIFICATION - -

TO ADVANCE the technology developed by electrical pioneers who designed and applied electric railway equipment to conquer mountains and to speed terminal traffic — there's a task to try your temper!

During the business life of young men who now are students, thousands of miles of railroad will be electrified — the undeniable economies of electrical operation make this advisable. To carry out such a program will call for the services of many of the best-trained men — in the industries allied with electrical manufacturing as well as in the electrical industry itself.

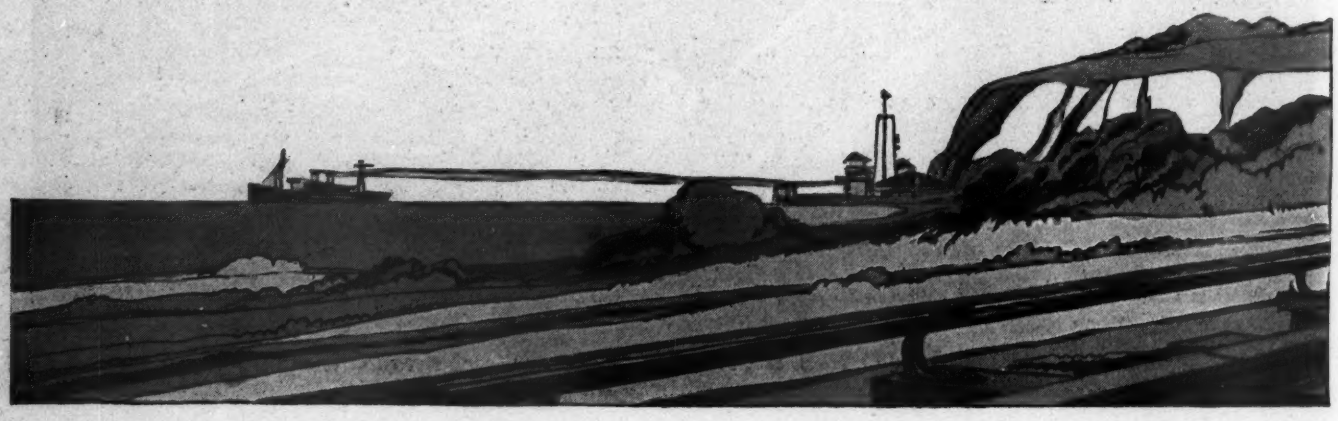
Out of college, established in your profession, it may be *your* job to direct a part of this onward march of electrification.

General Electric has equipped more railroad right-of-way and electrified more lines than any other company. For the future, General Electric anticipates a continuation of the vision, skill, and progress which have thus far marked its contribution to industry and transportation.

Booklet GEK-55 tells about some of the railway electrification projects with which G-E engineers have been identified. Address your request to Publicity Department, General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

95-771DH



-IN THE FUTURE....

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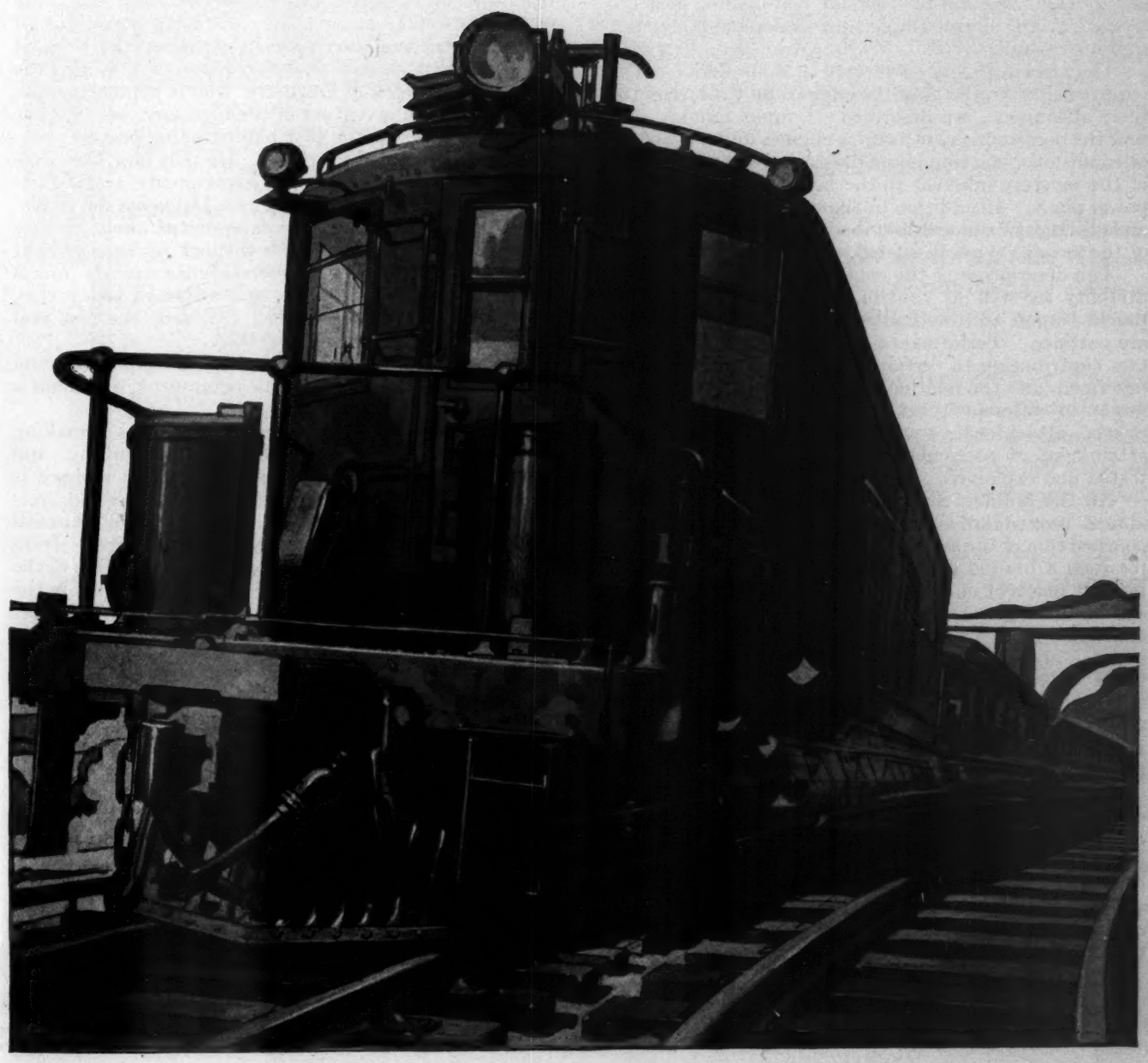

Recent Books

THE AIRPLANE AND ITS ENGINE. By C. H. Chatfield and C. F. Taylor. McGraw-Hill Book Co., Inc., New York. 329 + vii pages. 209 illustrations. Index. Price $2.50.

In the field of aeronautical literature there have been few publications dealing with the semi-technical side of aviation in terms easily comprehensible to the layman. Professors Chatfield and Taylor have contributed a volume which deals very thoroughly with the technical features of the airplane in just the manner necessary. The work provides interesting as well as instructive reading, and almost before one realizes it, one is well acquainted with the nomenclature and functions of the component parts of the airplane.

In a very logical and progressive manner the main portions of the airplane are described and commented on. With the aid of several excellent diagrams the designations and functions of the various elements are shown. The effects of different airfoil sections are plainly exhibited and the fuselage and landing gear are treated in the same simple and understandable, but thorough manner.

The airplane engine is treated in some detail. The required characteristics of the engine and the method of their attainment are described. Graphs quickly present the performances of various engines under a variety of conditions, and numerous illustrations remove much of the mystery inherent to the layman in the airplane power plant. In addition to the motor, both propellers and cooling systems are described and the relative merits of the various types discussed.

The description of the control system is very clear. Stability as well as control about all three axes is touched upon and methods of attainment of stability are outlined. Performance is not overlooked; the factors contributing to certain types of performances are described, and the relations between the effects of each factor in different types of performance are shown. Special attachments (such as superchargers) for the attainment of particular performances are well illustrated and explained.

All the familiar airplane maneuvers are defined in almost unmistakable terms. In addition, the actual construction of the airplane is gone into very thoroughly for such a limited space. There seems hardly an important phase of modern airplane construction of interest to the layman and non-technical student that is omitted. Not content with the construction of the airplane, however, the authors also reveal the design and mode of action of airplane instruments in a simple manner. Finally, the airplane as a whole is considered, with special regard to the separate requirements of various forms of military and commercial aviation and the design of ships to meet these requirements.

The outstanding feature of the whole volume, however, is the profusion of illustrations and the almost uncanny relations which they bear to the text. The illustrations are not merely a lot of "pretty pictures" but each photograph or diagram explicitly illustrates or emphasizes some point in the text. The care and consideration with which these detailed illustrations must have been chosen certainly deserves credit. Anyone could get an excellent idea of aeronautics merely by studying the pictures; but with the aid of the text the points are impressed almost indelibly on the brain of any serious-minded reader. From the point of view of interest and usefulness to the layman or student this volume deserves a place in everyone's library as a serious treatise on present-day aeronautics.

G. P. B.

PRACTICAL AMATEUR PHOTOGRAPHY. By William S. Davis. Little, Brown and Company, Boston, Massachusetts. 245 pages, index, glossary, illustrated. Price $2.00.

With this volume William S. Davis introduces the reader to photography. He begins by giving something of the historical background, and telling something of the men who first developed it, including the work of Wedgwood and Niepce who were pioneers in leading the way, and the work of Daguerre, who is popularly associated with the invention of photography, because the daguerreotype was the first photographic process practical for commercial purposes. He tells how Daguerre became interested in Niepce's experiments, and a partnership was formed in 1829, how Daguerre developed plates requiring an average exposure of about twenty minutes, which represented a distinct advance at that time, and finally how daguerreotypes quickly found recognition with the public, and although today they have been far surpassed, they represent the first real beginnings of modern photography.

Following this historical section is a chapter devoted to the selection of photographic equipment, which has a great deal of practical value.

The book takes up in detail such subjects as making negatives, prints, special treatments, mounting, and retouching. One of the things particularly stressed is the difference between "record" photographs and "pictorial" photographs, the first being purely mechanical copies of the subject matter, the latter a "picture" from the artistic point of view, giving an interpretation of the chosen material. This part of the book is probably the most valuable. It is illustrated with examples of beautiful photographs, and with reproductions of paintings in order to show the methods of composition. Chapters are given to compositions containing figures and animals, landscapes, ships and the sea, and architecture, with examples of these varying types.

The use of various types of filters, and of different kinds of plates and filters is described, with the different effect produced by each, and their best application. Methods are given for taking photographs after sunset of moonlight scenes, and the amount of exposure necessary.

The book has a list of references at the end of each chapter, besides containing a bibliography in the rear. It also contains a good glossary, and an index.

A. B. B.

Smith-mixed Concrete *for Milwaukee County Court House*

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Mixers — Concrete, Plaster and Mortar.

"Concrete—Its Manufacture and Use," a complete treatise and handbook on present methods of preparing and handling portland cement concrete, will be gladly sent on request to engineering students, faculty members and others interested.

NEC

One of the largest county court houses in the United States is nearing completion at Milwaukee, Wisconsin. This new eight million dollar building of classical architecture takes an imposing position on its raised elevation.

General dimensions show a length of 450 feet, a width of 200 feet and a height of 200 feet. In the foundation, 6,700 piles were sunk in order to provide a secure base for the heavy structure. There were 12,000 tons of steel used in the building and the limestone order, which was third largest placed in the United States during 1929, amounted to 303,000 cubic feet. The six columns over the entrance are 7 ft. 6 in. in diameter and are 60 ft. high.

Among the N. E. C. machines used on the Milwaukee County Court House was a large Smith Tilting Mixer of 2 yard capacity. With the famous Smith end-to-center mixing action, the big tilter mixed 10,000 cubic yards of concrete—Smith-mixed concrete for permanence.

National Equipment Corporation

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Milwaukee, Wisconsin

PROFESSOR ERWIN H. SCHELL

Acting Head, Department of Business and Engineering Administration

Erwin Haskell Schell, Professor of Business Administration, was born in Kalamazoo, Michigan, on September 29, 1889. In the years since then he has had a great wealth of experience in the business world and is now actively engaged as acting head of Course XV in dispensing the knowledge thus gained to Tech students.

Professor Schell's preliminary education was obtained at the public schools of Kalamazoo. In 1908 he entered the Massachusetts Institute of Technology in Course II. Four years later he received his degree of Bachelor of Science in Mechanical Engineering and entered the employ of a New England concern as Operations Manager. From 1913-1915 he held the position of resident engineer with a Boston firm of management consultants and during 1915-1916 was employed by an ammunition manufacturer as industrial engineer and labor manager. Prior to joining the Faculty of the Institute in 1917, he also served as treasurer of a manufacturing company located in Boston.

Being interested in education, Professor Schell has been associated with both the Institute and Harvard for several years. From the time he became connected with the Institute in 1917 until 1927 he was part time Assistant Professor of Business Management. During this time he was also associated with several business concerns and research organizations in and around Boston. In 1927 he advanced to the position of Associate Professor of Business Management. From 1924-1928 he was also Assistant Professor of Industrial Management in the Harvard Graduate School of Business Administration. In 1929 the Institute made him Professor of Business Management and the acting head of the Department of Business and Engineering Administration.

While at the Institute he has been engaged in a variety of business and economic research. In conjunction with this research, Professor Schell has written several industrial treatises. The first of these, "Technique of Executive Control," was published in 1924. This was followed by "Cotton Manufacturing Industries of New England" in 1926 and "Problems in Industrial Management" (in collaboration with H. H. Thurlby) one year later. In addition to being responsible for various articles in management periodicals, he was a collaborator for "Recent Economic Trends" published in 1929 by the National Bureau of Economic Research.

Professor Schell is actively associated with several organizations. Besides being a member of the American Management Association, the Boston Chamber of Commerce, and the American Society of Mechanical Engineers, he is Director of the Taylor Society. He also belongs to the Union, Twentieth Century, and Executive's Clubs of Boston as well as the Theta Delta Chi fraternity.

Professor Schell's hobbies include the raising of his two children, and money for needy educational enterprises. Also, he is quite interested in the taking and projection of amateur motion pictures.

Textile Research

(*Continued from page 77*)

this direction has been made very complete and adequate by the kindness of the Corporation. In no other manner is it possible to study the character and composition of the individual textile fiber. Identifications and microscopic determinations of great importance have been made by means of polarized light and a careful study of fiber cross-sections.

In this connection it is interesting to note that the textile staff has made numerous researches and designs for the textile industry through the division of industrial cooperation and research. A few years ago a complete research laboratory for both chemistry and physics was designed and installed for a felt company, and numerous special machines and devices constructed for its individual use. The staff has recently completed some three years of research for a tire manufacturer, dealing especially with the physical properties of supertwisted tire cords. In this connection, also, several unique and elaborate machines were designed for measuring the effects of repeated stress upon tire cords of varying degrees of twist and composition. One member of the staff, Mr. K. C. Biswas, is at present developing a textile research laboratory for a large cotton mill. These cooperative efforts of the textile staff bring a very pleasant and satisfactory reaction from the textile industry as a whole. While textiles are suffering the same depression felt in other lines of business at present, it is interesting to note that many special lines, such as mechanical fabrics, and especially knit goods, are in a fairly healthy and profitable condition.

The textile industry, as a whole, has come to recognize the Institute as a place to which they may bring their hard questions and precise determinations, with the full expectation that they will receive a thorough and comprehensive analysis and unbiased judgment in regard to their products.

Cement Manufacture

(*Continued from page 83*)

tion with power and light. The electrical energy used in the production of cement, if paid for at household rates, would cost more than the cement itself.

But all of these operations attend only the birth of cement. Just as the raw materials were quarried and processed to make cement, so will cement be used as the essential of concrete. This powder, whose evolution has been so carefully watched and guided, is the principle ingredient of the concrete with which are built highways, bridges, and modern fire-resisting structures.

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Made of extra quality cotton yarn, carefully inspected, and guaranteed free from all imperfections of braid or finish The colored spots are our trade-mark, used only with this quality.
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SAMSON CORDAGE WORKS : : 89 Broad Street, Boston 9, Mass.

Sewage Treatement

(*Continued from page 78*)

return sludge. The tanks are of the spiral flow type with curved baffles, the waterway being 22 feet wide by 15 feet deep They are of the four pass type giving a total length of flow of about 1380 feet. Air is to be admitted at the bottom of one side of each channel through porous plates. Piping and control facilities are to be housed in an operating gallery.

From the aerating tanks the flow passes to the final settling tanks These are 32 in number which, with two of the tanks out of service, give a rating of 1000 gallons per square foot per day at average rates of flow plus 25% return sludge. The sludge will be removed from both the preliminary and final settling tanks by mechanical sludge removers. The plans have been drawn up so as to receive bids on sludge removing mechanism either of the revolving type or the conveyor type. In the case of the final tanks sludge is withdrawn near the influent and an especially long effluent weir is provided.

The discharge to the river is through two conduits essentially at the bulkhead line. The return sludge pumping units are to be set up in two separate stations, four pumping units in each station, each with a capacity of 15 million gallons per day. With one unit in each station out of service this will provide a return sludge capacity equal to 50% of the average daily flow of sewage.

Compressed air for the aerating tanks will be provided by means of six motor driven centrifugal blowers each of 42,500 cubic feet per minute capacity. These units will be located in the main pump and blower house and will supply air normally at 7.75 pounds pressure. Provision will be made for the filtration of the air passing to the blowers. All power units are to be electrically operated.

The disposal of the sludge produced in a large plant of this nature, located in the center of a populous community, is a matter of great importance. Provisions are to be made so that the sludge can be disposed of at sea, and plans are being drawn for the construction of a trial plant for the recovery of fertilizer from the excess activated sludge. The first installation will be limited in size. Its extension to capacity requirements will depend upon the results secured in the trial plant. The sludge removed from the settling tanks will be pumped to a decantation and storage tank located on the waterfront. A dock is provided here so that specially constructed ocean-going tankers can receive the sludge and carry it to sea. Provisions are to be made so that surplus liquid may be decanted in the storage tanks and returned to the treatment works in order to limit as much as possible the volumes for shipment.

The shipment of sludge to sea will take place in specially constructed tankers, each of 1500 tons capacity. These vessels are to be about 250 feet long with a beam of 43 feet, six inches, and will draw about 11 feet of water when loaded. They will have twin screws, powered by two 600 h.p. Diesel engines, and will have a maximum speed, when loaded, of 10.25 knots per hour. They will be loaded and unloaded by gravity, the storage tanks on board being so arranged that free drainage can always be secured. To meet State and Federal regulations the sludge must be dumped at a point 10 miles from the nearest land and this will entail a round trip of some 65 miles.

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BROWN & SHARPE

"World's Standard of Accuracy"

Chicago Exposition

(*Continued from page 79*)

of this building due to its limited life. However, the engineers employed 16,000 pounds per square inch as the allowable tension stress in the steel members which is a value commonly employed in ordinary engineering procedure.

In addition to this circular structure the Transportation Building has a standard exhibition space 1000 feet long by 140 feet wide. The structure to house the steamship model is in this building, which is kept free from columns by a trussed roof.

Building Cool in Summer

Every effort, within the limits of practicability, is being made to keep this building cool in summer heat. Walls and roof are insulated. Steel sections, from which the walls are constructed, are in the form of a channel turned toward the inside of the building. Insulation board is fastened to the inside of the channels. This produces an air flue inside of each channel. These flues run vertically and are open at bottom and top to outside air so that air can circulate by convection up through the channels and remove much of the heat absorbed by the steel. The building will be force-ventilated by air fans mounted in the walls. No ducts are provided since the whole structure is utilized as a duct. Air is taken in on one side of the building and discharged on the other.

This structure has neither windows nor skylights but will be artificially lighted at all times, which is in line with the latest practice in museum lighting. It has been found that all exhibits of miscellaneous articles can be shown to best advantage when light is fixed in quantity and under complete control as to direction and amount. Interior illumination equipment is not being installed at present as it is desired to take advantage of any developments which may come out of present intensive research in illumination laboratories.

Several of the buildings for "A Century of Progress" exposition, which have so far been designed, are to be constructed with steel frames, for the most part with bolted connections to permit easy demolition and to give them a high salvage value. Finding foundations for these steel frames proved to be quite a problem because all of the land on which the exposition is to be built has been filled into Lake Michigan during the ten years past. The filling material varies in character, sand, hydraulically deposited, various clays excavated from building sites, and all sorts of organic waste material from city streets and alleys, and from demolished buildings. Such sub-soil offers some fair and some bad foundation conditions.

Under the Administration Building such sub-soil conditions extend below the basement level a distance of 75 feet or more, offering little prospect for gripping piles. Because of the light weight of this structure, it was decided to use spread foundations large enough so that the dead weight bearing value, which the soil under them would be called upon to bear, would not exceed 500 pounds per square foot. Footings were made continuous in one direction so that any unequal settlement would be compensated for by the footings acting as continuous girders.

Floor systems of the Administration Building are made up of steel truss joists, on which is placed a 20 gauge steel deck made up of interlocking channels cold rolled from sheet steel bands. A composition finish floor will be placed on this sheet steel underfloor. Roofs are of similar construction except that an insulation board is placed on top of the steel deck, and this is then covered by a built-up roof.

The exterior walls of this building are made up of a wall board made of a composition of portland cement and asbestos fiber, highly compressed. This wall board is mounted on metal studs fastened to the steel frames. The interior board is gypsum. For insulation against heat loss, the interstices are filled with rockwool. Interior partitions are of gypsum board mounted on metal studs.

Two fire walls of gypsum divide the building into three sections. The building is 340 feet in length, in the form of an "E" with wings extending back 150 feet. It is two, three and four stories in height. It contains the offices of the World's Fair staff, an exhibit hall for pre-fair displays, and a large reception room for the trustees. Floor levels in the wings of this bulding are staggered half way between the floor levels in the main portion in order to facilitate access between various departments.

Continuous factory type sash is used for windows in this building but each alternate vertical muntin bar, in standard factory sash design, has been omitted to improve appearance and to facilitate washing the glass. Improved methods of glass manufacture have practically abolished the saving which formerly led to the use of small sized panes. Larger panes are now more economical than smaller ones.

Illumination of this building has been accomplished in a rather novel manner. It meets conditions more economically than a standard electrical illumination installation. Corridors and storerooms have ceiling fixtures, as does the Trustees' room. Offices are to be lighted by an inexpensive type of inverted reflector mounted on a portable floor standard. These fixtures can be shifted easily to meet changes made in office organization. Both high and low tension wiring for the offices are carried in a conduit base.

Another motive besides that of economy has been behind all study of designs of buildings for "A Century of Progress" exposition. The display theme of the exposition, to be held in Chicago in the summer of 1933, is to tell the story, of the development of science during the century, and of its applications to all forms of human endeavor. Every effort is being made to utilize, in exposition buildings, the latest products science has made available to the building industry. It is hoped to make the buildings themselves, scientifically and artistically, a part of the exhibits of the exposition.

Utilizing these materials and systems of construction, the buildings have taken entirely different form from those of former expositions in the United States. Architectural effects are obtained by arrangement of masses and planes rather than by use of elaborate detail and ornament. Since exterior materials are to be painted, it becomes economically possible to use brilliant colors.

It is hoped that the efforts put forth to produce buildings which not only utilize the latest materials produced by science, but are architecturally satisfying in every way, will result in other efforts along the same lines, and that all such efforts will redound to the benefit of the building industry and to the public which builds and utilizes buildings.

THE FOE OF INDUSTRIAL WASTE ▲▲▲▲▲

MILLIONS of dollars of capital are dissipated yearly in discarded machinery and equipment. This figure would be many times as large but for the use of oxy-acetylene welding in the repair and maintenance of plant machinery. Much more can be saved by still broader application of the oxy-acetylene welding process.

The oxy-acetylene process of welding and cutting metals has many other interesting applications in the design, construction or fabrication of metal parts or structures. Tomorrow's engineers will be expected to know how to apply this modern metal-working process. Several valuable and interesting technical booklets on design and applications are available. Write us if you are interested.

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Modern Newspaper

(*Continued from page 75*)

typing and is principally a process of duplication. The form is placed on a bed and by means of pressure an impression is made on a piece of matrix or "flong." This pressure between 1000 and 1400 pounds per square inch may be applied by a roller action or by direct hydraulic pressure. This mat being flexible is placed in a machine having a curved back and type metal is then poured against it making a semi-cylindrical plate of definite thickness which is clamped on the press. This step in newspaper production has undergone very little change in method since its inception and the advance in production has been accomplished by improving materials and machine design. There are opportunities for still greater improvement by the application of engineering principles to the problems of stereotyping.

The plate clamped on the press cylinder is now in a position to be covered with ink and to be impressed against paper to produce the printed page. This brings into the process the two very important items, ink and paper. News ink, so called, is a mechanical mixture of refined oil and carbon black, the grades and proportions of each in the mixture having a great influence on the quality. Much time has been spent in the chemical laboratories perfecting the quality of ink and improvements may be looked for in the future. "Newsprint," the trade name of paper used in newspapers is a large factor in the appearance of the printed product. It is a mechanical mixture of wood pulp and sulphite pulp manufactured, shipped, and handled in rolls weighing about 1500 pounds.

The operation of the press is normally as follows: The continuous sheet of newsprint passes between the the cylinder with the plate attached and a companion cylinder covered with a resilient blanket. These two cylinders are rotated in opposite directions by meshed gears and are in such contact that the sheet of newsprint is drawn through at the same peripheral speed. The plates are continually fed with a film of ink which transfers to the paper at the point of contact of the two cylinders thus producing the printed paper. The printed sheet then passes to a folding device which folds it twice into the form. The cylinders are rotated at from 250 to 500 R.P.M. and produce a speed of travel of the sheet of newsprint of from 900 to 1800 feet per minute. When it is considered that the adjustment of contact between the cylinders is measured in 1–1000ths of an inch and that the thickness of the sheet is about .003" it is evident that a printing press is a machine of great solidity and accurate machine work. Much engineering ability in machine design and in electrical control apparatus has been expended in our modern machines and the printing press has yet to receive its full share.

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Charles T. Main '76 Charles R. Main '09

The "Gravity System"

The foregoing paragraphs give a general idea of the steps necessary in manufacturing a newspaper, but emphasis should be laid on the importance of correct layout of these steps. The majority of newspaper plants have been designed without this important consideration but in 1922 a plant was designed and erected that treated the newspaper plant as a pure factory and subsidized all other considerations to a correct sequence of physical steps. This layout has come to be known as the "Gravity System" and is similar to the "flow sheet" or "progress chart" of any continuous manufacturing operation. (Illustration). The building to afford the necessary space for all departments is seven stories with basement, about 100 feet deep by 150 feet long. The top floor is devoted to the less urgent needs of publication. The sixth floor is devoted to general business offices and the fifth floor to the first of the necessary steps before mentioned, the Editorial Department. The fourth floor is devoted to the Composing Room containing linotype machines, proof room, advertisement preparation and kindred operations and also that portion of the stereotyping known as the moulding process. This permits all type and forms to be handled and retained on this floor thereby dispensing with vertical transportation by elevator. Mats or flongs are dropped to the third floor plate casting room in a chute. The plates are taken to the battery of presses on the same floor with a minimum of transportation and loss of time. The paper rolls are unwound into the presses by mechanical means on the second floor immediately below the machines. The finished product is conveyed from the presses to the ground floor by means of a spring wire conveyor which delivers them at convenient points for wrapping and mailing.

The operation of this plant has demonstrated that a carefully planned and efficient layout does aid greatly in production and has shown that the continuous progression of material without retracing is a great saver of the minutes that are so precious to the publication of a modern newspaper.

Newspaper production has been governed for so long by traditional methods and procedure that any engineering innovation has until recently been looked upon with suspicion. The industry has now become one of large units in which economic operation is increasingly important and which presents many problems of various nature that can only be solved by the keen application of engineering principles. Such a condition opens a new field for the young engineer and his efforts will undoubtedly be welcomed by the progressive newspaper publisher.

Steam Heating

(*Continued from page 74*)

installed, the use of small turbo-generators, delivering exhaust steam to a feed water heater is usually justified.

Distribution Systems

There are two methods of steam distribution in use. One method consists of a trunk pipe decreasing in size as the quantity of steam decreases with a number of lateral pipes laid in intersecting streets to form a more or less inter-connected network. This, the simplest form of distribution system, is used in the majority of cases.

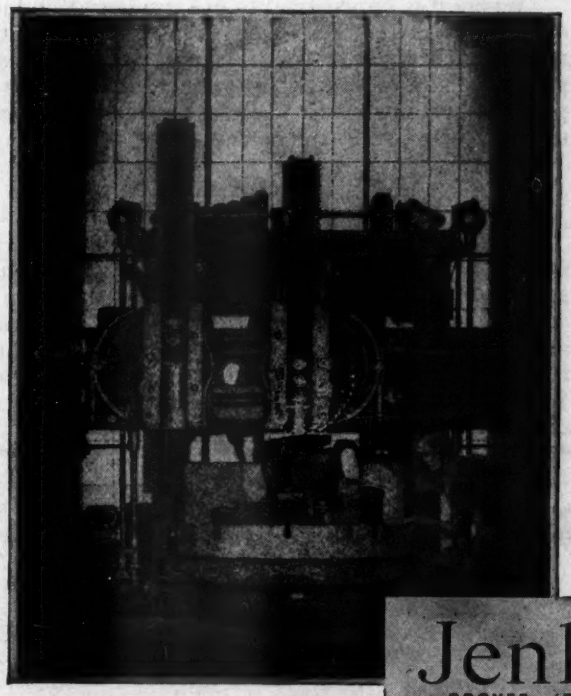
The second method consists of a system or network of mains to which steam is supplied by feeders extending from the boiler plant to selected points on the network. Additional feeders may be constructed to supply a district which becomes heavily loaded. The method of operation consists of maintaining a constant pressure at the point where the feeder connects to the network. This system usually operates at low pressures with high pressure feeders.

Very high velocities of flow are perfectly feasible and in many cases a velocity flow of 50,000 feet per minute exists, while velocities as high as 75,000 feet per minute have been observed. The use of high velocities and large drops in pressure make it possible to use pipes of a relatively small diameter which materially reduces investment costs. The distance over which steam can be transmitted has been found to depend only upon the pressure drop and the pipe diameter. The greatest distance over which steam is actually being transmitted to a consumer is approximately 15,000 feet. Limitations of the areas served by district heating systems are not due to difficulties in steam transmission but to the size of the districts which can profitably be served.

When water is costly or requires elaborate purification it is found economical to return the condensate from consumers' premises to the plant, but usually the cost of additional piping for this purpose is not warranted. Several forms of pipe conduit are in common use. The more permanent forms of construction employ concrete or vitrified clay tile where favorable conditions permit. Cast iron conduit, with either flanged or bell and spigot joints, is used in very wet ground.

Heat Losses

Although the heat loss from underground pipes is an important item, it is not so serious as might be supposed. The efficiency of distribution in a well-designed system is from 80% to 90%. The loss of from 10% to 20% includes, not only the condensation loss in the pipes, but loss from steam leaks and other miscellaneous causes. Tests which have been conducted indicate that heat loss varies from 50 to 75 B. t. u. per square foot of pipe surface per hour, for pipes laid in dry soil and fairly well insulated.



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Expansion Devices

The linear expansion of pipes is an important distribution factor. The slip joint, which is quite widely used, will permit several inches of expansion travel. It must, however, be so located to be accessible for the renewal of the soft packing.

The so-called variators, which depend upon the flexure of copper diaphrams are capable of taking care of 2¾ inches of movement and are located at intervals of 100 or 120 feet. The corrugated copper expansion joint is capable of taking care of ½-inch of movement for each corrugation. The two latter devices require no attention and need not be accessible. In general, the trend is toward the use of the slip joint and the corrugated copper joint.

The use of fusion welding employing either the oxygen-acetylene or the electric arc method for joining underground pipes is quite general and has many distinct advantages. Lateral connections to supply individual buildings can thus be jointed without the insertion of a fitting.

It is sometimes found desirable to install the pipes in tunnels large enough for a man to enter. Where several large pipes must be placed in the same street, it is often more economical to construct a tunnel. All pipes are insulated using largely asbestos sectional covering with sponge felt. The covering has a thickness of approximately 3 inches. This insulation is then protected by roofing paper securely strapped to the pipe and painted with a moisture resisting compound.

Consumers' Apparatus

Experience has conclusively demonstrated that in order to supply heating service which will be satisfactory both as to quality and cost, the operators of the district heating system should be consulted regarding apparatus and equipment in the consumer's premises. Complaints are usually due entirely to defective consumer's equipment and consequently its proper design and maintenance is very important.

There is an essential difference between the operation of a heating system in which fuel is burned and one using steam from a district heating system. In the former case the amount of heat used is governed by the amount of fuel fed to the boiler and is, therefore, under direct control. In the latter, the supply of heat is practically unlimited and carelessness in the control of it, results in excessive consumption.

The special apparatus which is necessary to adopt a consumer's heating system to the use of steam from a district heating system consists of:

a. Pressure reducing valve to deliver the steam at a constant pressure to the consumer, required only on high pressure systems and usually supplied by the district heating company.
b. Pressure reducing valve to regulate the delivered pressure to pressure desired in radiator or process.
c. A trap which will permit the drainage of condensation without leakage of steam.
d. An economizer (not always required) to utilize the heat in the condensation.
e. A meter (supplied by the district heating company) to measure the amount of steam used.

Meters and Rates

The use of meters for steam heating service is universal. Steam is sold in units of 1,000 pounds and charges are often subject to adjustment due to changing prices of coal. Price schedules usually employ the block step method of charging, although some of the larger districts heating companies employ a demand rate which recognizes load factor.

Other companies use the two-part rate by which the consumers are assessed partially on the basis of their total steam consumption. A demand rate tends to lower the charges for service to those classes of consumers which use heat for many hours of the day such as hotels, clubs and apartment buildings, and therefore, makes it possible for district heating service to compete more successfully with the individual plant.

The art of metering the heat supply has been developed to a very satisfactory state. One method is to measure the condensation at its point of discharge from the consumers' piping. Where this method is used, it is necessary that the condensate be collected at one point without waste. This method cannot be employed where steam is used in open jets.

Where it is impractical to use condensation meters, steam flow meters are used. There are a number of meters of this type, most of which employ the Venturi principle. Flow meters are generally used on high pressure systems where there is a reasonably constant delivery pressure to the consumer.

Conclusions

The results of the combined experience of many district heating companies establishes a basis for several fairly definite conclusions regarding the engineering and economic status of district heating.

The distribution of the quantities of steam required for heating, even in the larger cities, may be successfully accomplished and the areas covered are fixed by

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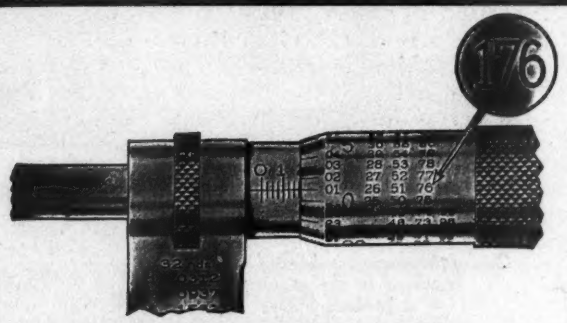

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economic and not engineering limitations. The service must be limited to favorable districts if it is to be profitable and there is no prospect of a city-wide heating service in its present stage of development.

The use of hot water for commercial district heating has been definitely abandoned in favor of steam. The generation of electricity in district heating plants is desirable in some cases and the complete application is being considered in some plants.

A district heating system is desirable as an auxiliary to an electric supply service as a means of eliminating the individual plant.

District heating has its most profitable and most popular field in the business districts of large cities and there is an increasing demand for the service. It depends for its success upon certain climatic, economic and physical conditions.

It is not profitable in residential districts, made up of detached single family dwellings, and with the exception of community developments of certain types it appears that other methods are satisfying the demand for automatic heating.

The supply of steam to manufacturing industries for heating and for manufacturing processes affords a promising field for future development.

The district heating industry is on a sound basis and its future expansion in the fields in which it is profitable is assured.

Case-Hardening

(*Continued from page 81*)

Wear of Cylinders

1. On car with cast iron cylinders after 30,000 km. (18,630 miles) 0.016″
   On car with nitrided cylinders 0.0008″
2. Aviation motor after 100 hours running
   Wear of cylinders of heat treated steel 0.0032-0.004″
   Nitrided cylinders 0″

Oil consumption (same conditions) per H.P. hour

	New Motor	*After 100 Hours*
Cylinder of heat treated steel	4-5 grams	12-15 grams
Cylinder of nitrided steel	4-5 grams	4- 5 grams

Coste and Bellonte in their trans-Atlantic flight used a motor in which the cylinders, regulating mushrooms, tappet faces and timing gears were made of nitrided steel.

Some of the uses of nitrided steel follow: Crankshafts, Wrist Pins, Spinning Rings, Spindles, Pinions, Steam Nozzles, Cams, Bushings, Valves, Timing Gears, Small Gears, Clutches, Ring Gears, Celluloid Moulds, Brick Moulds, Die-Casting Moulds, Worms, Chucks, Camshafts, Piston Pins, Relay Shafts, Paper Rolls, Master Cams, Gauges, Pump Shafts, Rollers, Piston Rods, Drawing Dies, Master Gears, Tappets, Steering Mechanisms, Sectors, Steering Sectors.

A great deal of attention is being given to the nitriding of special tool steels and cast iron. Present results indicate that these materials in the nitrided condition will play an important part in special applications where resistance to wear is of paramount importance.

In view of the properties of nitrided steel, it can be truthfully stated that its level development represents one of the most important metallurgical accomplishments in recent years.

ICE and RUST
Cannot Attack the
Vital Parts
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MATHEWS
MODERNIZED
HYDRANT
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No water or dirt can seep down around operating nut to freeze or clog.

The stop nut prevents buckling of stem if excessive pressure is applied in opening the hydrant or turning it the wrong way to close.

The location of the stuffing box prevents water entering the head or revolving nut to freeze or cause rust.

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Steels

(*Continued from page 84*)

Too much stress cannot be put on the excellent combinations of physical properties obtainable in this material with the proper heat treatment. Many users, or prospective users, of this type of material have failed to utilize the best properties of the metal and in some instances failures in service have been reported, which were quickly corrected by proper heat treatment.

The free cutting stainless iron variation of the original Stainless Iron has solved many problems in the application of corrosion-resisting steels to parts requiring much machine work, particularly screw machine products. It is possible to procure stainless iron that will not necessitate changing cutting feeds and speeds from those used for ordinary steel.

For parts requiring no special degree of hardness or physical properties, this material should be purchased in the annealed condition.

This brings up the question of obtaining the proper combination of hardness and tensile strength sometimes so necessary in many products. For a time it was thought that in order to use a free machining stainless iron, it was necessary to sacrifice considerable hardness and tensile strength to acquire ease of machining. It is now possible to secure this free machining material either annealed, or heat treated to meet the most exacting specifications, and still utilize the unquestioned advantages of ease of machining. It is being furnished for some applications with a Brinell hardness of 250 with a corresponding tensile strength of 125,000 pounds per square inch, and in this condition is being machined with ease.

We come now to the 18% Chrome 8% Nickel alloy. While this steel is not a "cure-all" it has properties which make its application possible to a very great extent to products manufactured from sheet or strip. It possesses a high resistance against rupture and a remarkable ductility in the cold state, which makes it capable of being pressed or drawn into a number of intricate shapes. It is extremely tough and will stand drastic deformation without bursting. It shows its deep-drawing qualities best when in the fully softened condition.

At present the largest tonnages of this material are being used in three important industries; automotive, food and oil. The largest use has been in automobiles, although the oil refining industry is a close second, and the food industry is turning to it rapidly. The increased use of this material in 1930 came from its adoption by a large number of users in comparatively small quantities, rather than from large tonnages used by any one industry. In the automotive industry it is being used for radiator shells, headlamps, running board moldings, radiator caps, and bolts subject to severe corroding influences.

In the oil industry it is doing much to solve the difficult problems of corrosion, erosion, and oxidation. It is in constant use in tubular form in cracking still tubes, vapor lines, exchanger tubes, condenser tubes and topping still tubes. In sheet form it has found a ready market in the construction of air preheaters, bubble towers, tanks, and so forth.

The 18 and 8 alloy has come to be known almost universally as KA2 and this symbol will be used in referring to it. It is a chrome nickel alloy containing about 17-20% chromium and 7 to 10% nickel. It is manufactured in two grades according to its carbon content. KA2 contains from .08 to .16% carbon whereas KA2S contains less than .07%. Both alloys attain maximum corrosion resistance only when given a special heat treatment, consisting of heating to above 2000° F. and then cooling quickly, either in water or air. After this treatment they are fully austenitic and non-magnetic. While these alloys cannot be hardened by heat treatment, hot work carried out at fairly low temperatures, around 1500° F., and especially cold work, will harden them considerably, with consequent sacrifice of some ductility.

Welding

Arc welds should be made with coated KA2 electrodes. Welding may be done either with alternating current or direct current. With direct current the polarity should be reversed from that in ordinary steel welding practice; that is: the electrodes should be the positive, and the work the negative terminal. The voltage required varies with the thickness of the sheets to be welded and should be as low as practicable, ranging between 40 and 60 volts measured at the welding machine. The current should be between 75 and 125 amperes. On thicknesses of 3/16" or lighter, no bevelling of the material at the joint is required. Above 3/16" the joint should be bevelled and the material laid in two layers. Where successive layers of material are to be deposited, the weld material of the preceding bead should be allowed to cool thoroughly before the next bead is deposited.

Wherever possible, the metal deposit should be laid down in a continuous stream. Having no capacity for hardening by temperature effects, welds remain tough and ductile and do not develop a coarse, crystalline structure.

In acetylene welding, uncoated rods of KA2 should be used as filler material. Flame should be soft neutral or slightly reducing. The torch should be kept pointed in the direction of the work to preheat the parts to be welded, and the rod should be kept in the flame.

In welding, sufficient heat is induced at or near the welded area to cause carbide precipitation, which lowers resistance to intercrystalline corrosion. Therefore, for maximum resistance to corrosion, all welded parts should be subsequently heat treated, to redissolve these carbides, the temperature consisting of heating to between 2000° F. and 2200° F. and rapidly cooling. If possible, the entire part that has been welded should be given this treatment; if this is not possible, the part should be made of the low carbon grade (under .7%) as the lower carbon content reduces the carbide precipitation and hence maintains corrosion resistance. Rods of low carbon should be used.

The reference to the above subject made in the instructions on welding deserves a little further explanation. It is most important that this characteristic of KA2 be taken into consideration when contemplating the use of it on work subject to high pressure at high temperatures. KA2 is suitable for applications where temperature does not exceed 600° F. for pressure service.

It has been found that carbide precipitation occurs at high temperatures, which affects both the corrosion

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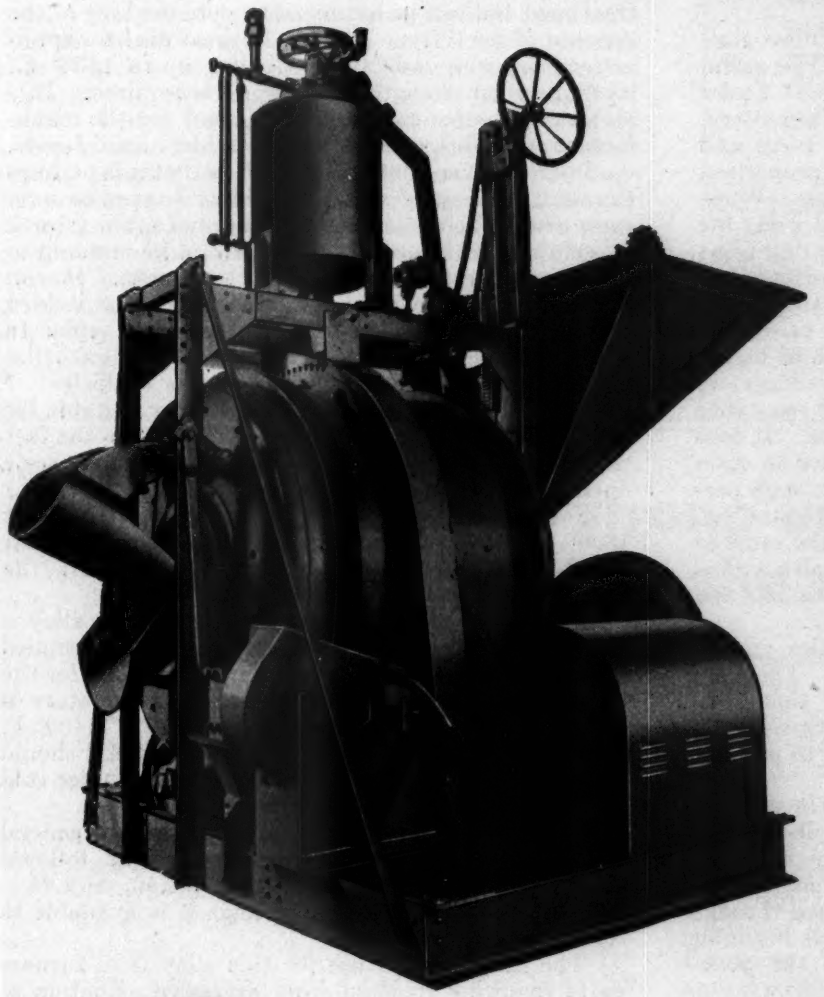

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resistance and the physical properties of the alloy. This change takes place regardless of previous heat treatment. Therefore it is quite necessary to limit the carbon content to less than .7% when the material is to be used at temperatures above 600° F., under pressure. The low carbon material raises the temperature limit at which this alloy may be used for pressure service to 1300° F.

These figures refer, of course, to the temperature which the metal itself attains. Beyond a metal temperature of 1300° F. neither the high nor low carbon types of this alloy will give satisfactory service for pressure applications.

The foregoing covers in a rather brief manner the outstanding characteristics of the 18 and 8 alloy. There are some variations of the original KA2 type which have lately come into use, designed for particular applications, and containing added elements.

Effects of Elements

The usual carbon content found in stainless steel is .30% and this is considered standard. The useful range of the element, however, is very narrow. Under .25% the steel will not harden successfully for cutlery, while above .40% the steel is difficult to forge and loses considerable of its non-corrosive properties, unless special heat treatments are resorted to. When the carbon is low, .15% or under (stainless iron) the material will not harden sufficiently for a cutting edge. Such a composition forges much easier and this low carbon material is rustless regardless of heat treatment.

Silicon in amounts in excess of .75% raises the critical point, thereby necessitating the use of higher hardening temperatures. It has the advantage, in higher percentages, of producing increased resistance to heat and gives better non-scaling qualities. It does not replace chromium in effecting resistance to stain and corrosion. It has the disadvantage, in high percentages, of increasing tendency to grain growth.

The effect of Manganese is very much the same as in carbon steel. It should be kept low although a certain amount is necessary to assist in rolling and hardening.

Sulphur and phosphorous are impurities and as such should be kept as low as possible. They are especially injurious to stainless steel in that they induce electrolytic action which causes corrosion. A modification of the sulphur content is used to produce the free-machining stainless irons.

Chromium is the principal element used in stainless irons and steels. Certain percentages of it in combination with iron render the resultant iron-chromium insoluble in water and many other solutions, so that by heat treatment, if the carbides are diffused through the mass, a metal can be produced which is insoluble and sufficiently homogeneous to remove the possibility of galvanic action.

When nickel is added to a steel it lowers the critical temperature in proportion to the amount induced, until .25% is added, at which stage the critical transformations occur below atmospheric temperatures, therefore a steel of this composition is austenitic. In the presence of chromium, much smaller percentages of nickel are required to induce this austenitic condition.

The presence of copper in stainless steel produces somewhat the same results as does nickel, except that large quantities of it do not render the steel austenitic. It raises the corrosion resistance to certain acids.

Molybdenum has a noticeable effect on the hardness values of stainless steels, raising them to a slight extent. It also aids the corrosion resistance towards some acids.

A typical analysis of the material generally known as Chrome Iron is as follows: Chrome 16.00 to 20.00%, Carbon .12%. This alloy is ductile and easily worked, either hot or cold. It cannot be hardened by heat treatment but can be hardened by cold working at the expense of ductility. It is used a great deal for applications requiring resistance to scaling up to 1500° F., where no great strength or toughness is required. It is also used to some extent in equipment for the manufacture and transportation of the milder organic acids.

It has one very noticeable fault in that it is perhaps the most difficult of all of the stainless types to weld successfully, being subject to abnormal grain growth at welding heats, and the welds cannot be restored to the original structure by heat treatment. It can hardly be recommended for fabrication into welded products where the welds must be relied upon to stand any amount of stress.

It does have the virtue of a very low coefficient of thermal expansion, which renders it very suitable for intermittent high temperature service, due to the fact that it permits of the retention of the protective scale during heating and cooling.

For forging, the proper temperature is about 1800°-1900° F., with a finishing temperature of about 1300°-1400° F. Under no conditions should the finishing forging be done above 1400° F.

Although we have just mentioned that this alloy is virtually unaffected by heat treatment, an anneal after hot or cold working is sometimes advisable for the removal of strains, etc. The correct temperature is 1400° to 1450° F. after hot work, and 1375°-1400° F. after cold working. After hot working, metal should be thoroughly soaked and cooled slowly. After cold working, an air cool will be sufficient.

Special heat resisting is furnished in two general compositions, with two carbon ranges as follows: chrome 20.00—30.00%, carbon .25—.50, or 2.25—2.75%. In the high carbon range it is available in cast form only.

The most general use for this alloy is in furnace parts requiring freedom from excessive oxidation at

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elevated temperatures, or in furnace atmospheres containing sulphur. It does not have the load capacity at high temperatures possessed by the chrome-nickel 18-8 type. It is extremely useful for making conveyor belts for continuous furnaces, for annealing pans, carburizing boxes, boilers, furnaces, etc.

This brief outline covers the outstanding grades of corrosion and heat resisting alloys in common use today. It by no means touches every detail of the application and fabrication of the metals, but may serve as a guide to users of the product, as well as help them through the rather tangled maze of trade names which, while of value, have in some cases made the intelligent application of the materials rather difficult.

Timber Underground

(*Continued from page 85*)

the operators. To avoid this, in case the ground is weak, the timber in the drift is designed to hold up a terrific load of rock. Spaced at 12 foot intervals are 12 inch steel "I" beams. These are fastened to the sides in two ways depending on the length of span. If it is less than eight feet, two steel pins are fixed in the side of the drift and a saddle is placed on them. On the saddle the beam is put. The pins are secured in the wall by filling the sides of the hole with cement. If the span is greater than eight feet, a cut is made in either side of the drift. The size of the cut is usually about two feet square and three feet deep. It is done by drilling holes as closely as possible along the sides, and two center holes. The latter are filled with explosive and fired, the resulting cut being the

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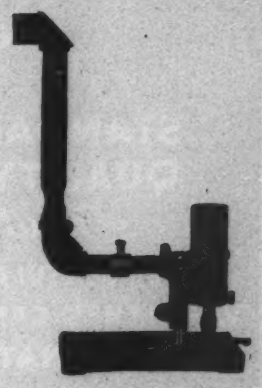

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In carefree days "before the war," a steel bolt was a steel bolt. It was made of any easily obtained steel that forged easily and took threads well. Industry moved forward . . . stronger bolts were asked for. Ordinary steels were improved to tensile strength of 45,000 pounds. Not enough. A bolt with forged-on head and tensile strength of 50,000 pounds was developed. Still not enough. Cold rolled steel bolts with tensile strength of 80,000 pounds were offered. They had a tendency to snap.

To fully meet the demands of modern high pressure and temperature technology, Crane Co. brought out for its cast and forged steel materials their Triplex steel stud bolts, of chrome nickel steel with tensile strength of 125,000 pounds. The limit is not yet. Even now, Crane Co. can supply bolts for valve bonnets and flanges with tensile strength of 140,000 pounds and retaining strength at well past 1000° F.

By exhaustive laboratory investigations, long carefully charted creep tests, detailed study of service conditions, Crane metallurgists have helped this development. With the same scientific methods they have as strikingly improved bodies, bonnets, discs and seats, stems, packing boxes . . . so that Crane valves and fittings can be supplied for higher pressures and temperatures than have yet been commercially projected.

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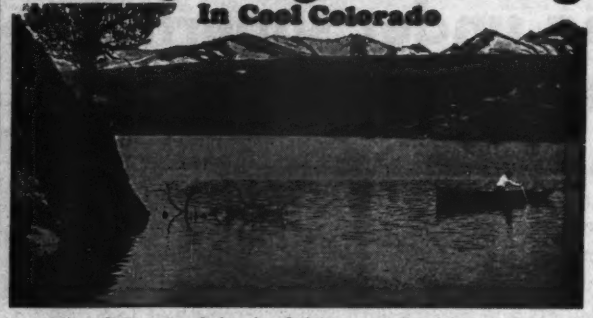


The Colorado School of Mines is located in Golden at the very foot of the Rocky Mountains. It is but twelve miles by paved road to the capital city of Denver, and but an hour's drive to the great Continental Divide, with streams and forests and snow-capped peaks rising to the sky.

The Summer School Engineers

Basic engineering courses in Mathematics, Chemistry, Physics, English and Design; Courses in Assaying, Geology, Analytical Mechanics, Graphic Statics, Strength of Materials, Thermodynamics, Physical Chemistry, and Plane and Mine Surveying; Preparatory subjects, for students deficient in entrance requirements, Advanced Algebra, Solid Geometry, Chemistry and Physics, are offered at the Colorado School of Mines Summer Session from

July 6 to August 28, 1931

This summer session is given especially for students who wish to make up work or to secure additional credits. All work is conducted by the regular faculty of the School of Mines. For complete description of class room courses, and field work offered in the summer session, write to the Registrar for "Quarterly Group L-10."

Colorado School of Mines Golden, Colorado
School of Mineral Industries

desired size. The ends of the beam are put in these cuts and the opening left is filled with concrete. On top of these is a set of beams perpendicular to the cross beams and another set composed of five inch "I" beams spaced one foot on centers. These are secured in place by blocking them against the back, at intervals of about six feet. The blocking tends to hold up the rock that is against it, while the longitudinal beams will catch anything that falls and prevent its obstructing the track.

Wood Supports Economize Steel

Where the drift is seldom used for haulage, the necessity of keeping the roof up is not so great, thus, to economize on steel, wooden support is used. The sets, as each complete support is called, are composed of three pieces, the two posts and the cap. The posts are usually of round timber twelve inches in diameter or greater, placed so that they lean in toward the center of the drift. On these the cap rests, usually twelve inches square. Wedges and blocks secure the cap against the rock above, exerting pressure enough on the posts to keep them in place. If they are fixed strongly enough to stay up the first few days, the pressure from the rock itself will keep them in place for the rest of the time. In some places the rock on the floor exerts an upward pressure. Where this exists, a fourth timber must be placed in the set across the bottom of the drift, under the posts. These supports are usually at eight foot intervals with a solid roof of six to eight inch timber on top, extending along the drift to hold up any small pieces that may fall and by their deflection giving warning when the pressure on them is becoming too great. A place supported this way is only temporary and is expected to last only a few weeks at best.

The ore is broken in stopes, rooms, sixty feet above the level. Between the level and the stope is a raise with a chute at the bottom. The ore, thrown in at the top, runs down to the mouth of the chute. Here it is held back by a gate until it is wanted. At that time the gate is raised and the ore drops into waiting cars. The inside of the raise is not timbered. At one side is the manway, or the incline that the men use to ascend to the stopes. It is divided into two compartments, one with a ladder for the men and the other with a long chute, used to hoist timber and supplies for the work above. The sides of the manway are formed by placing round timber skin to skin the entire length. The two compartments are separated by a four inch plank. A cover at the top prevents loose rock from falling on the men climbing up.

The stopes are forty feet wide and from sixty to one hundred and twenty-feet long. The height of the roof is seven feet. This results in an area of rock far too great to be expected to support itself. However, due to the fact that as soon as the stope has gone completely across the vein it is filled with waste rock and the work continues, using this as a base; the timber put in the stope is never recovered. Therefore, it is essential that whatever method is used must be cheap. To afford sufficient protection for the men, cribs are put in. These consist of round timbers, six feet in length of varying diameter placed in a manner resembling the formation of a log cabin. When these are built up to the top, they are filled with waste rock and covered with four inch planks, wedged against the roof. The cribs are usually spaced twenty feet apart longitudinally and ten feet transversely. Unless a huge mass of rock becomes loose these will hold up and, in

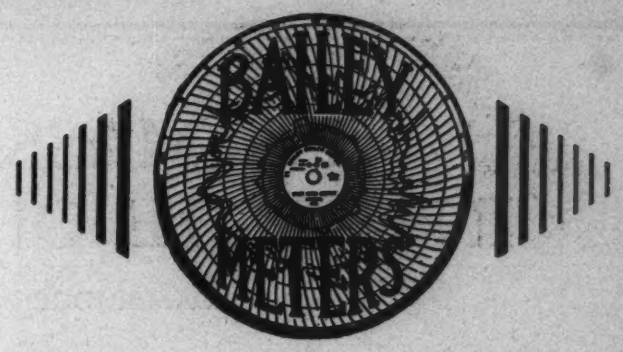
any case, they will give some warning of the excess weight before they give way. In case a slab becomes loose between them it is a comparatively easy matter to put one vertical post in under it and hold it up for the short time required. Under the terrific concussion of the blasting sometimes these cribs are shaken out of line and fall. When this happens, the roof directly above is scaled each day until it becomes reasonably safe and then a large number of posts are put in. The practice of the deep gold mines of the Witwatersrand in Africa uses instead of timber, round cement blocks shaped like pancakes and piled one on another to the desired height.

Equipment Support of Great Variety

So far we have dealt only with the support of the roof and of the men. The third class, the support of the equipment, is of such variety that a detailed description would mean little. However, the best example is the timbering of the shaft. In shafts used for hoisting ore or men, the practice favors the shafts being rectangular; for ventilation, however, they are usually round or elliptical, allowing a better streamline and greater efficiency of ventilation.

Obviously the timbering must start at the top and work down. It must be understood that the timber in a vertical shaft is built to withstand horizontal pressure only. Collar sets are put in first, consisting of long timber usually twelve by twelve extending as far as possible past the edges of the opening. With these as a base on which to work, the next set is started down. The spacing varies from four to six feet, depending on the type of rock encountered. Iron rods, known as hanging bolts, passing through the upper set and bolted to the bottom of the lower hold each member in place as the construction goes down. This part is only temporary, however, for posts are later set in between the sets at the corners to avoid any possible moving. Thus, the timbering of the shaft continues hanging one set below the next. On the outside of each lagging is placed, wedged in to make firm and causing the shaft to be rock tight. The lagging consists of two inch planks standing vertically outside the timbers, giving an appearance that closely resembles a box. These are secured in place by wedges. At given intervals, depending upon the weight of timber above, bearer pieces are put in. These are across the shaft with their ends in hitches in the wall, for the purpose of supporting the timber directly above them. The spacing varies from fifty to one hundred feet. If the shaft is to have more than one compartment, and nearly always there are at least four, divider posts may be put in and each compartment tightly lagged. One compartment is usually used for the air and water pipes and a ladder for emergencies or for repair work. The remaining compartments are for the skips, or elevators, known in mines as cages. Carefully aligned guides of four by six material, are placed on either side, to hold the skip in place as it goes down.

The use of timber herein described is not standard practice, almost every mine is different in this respect, and in the case of the mine described, differences can be noted on the different levels. To get some conception of the amount of timber used in this mine, one must realize that there are approximately twelve miles of drifts and over one hundred stopes, each using as much or more material than described. The daily consumption of timber has been estimated to be thirty carloads when the mine is working at capacity.



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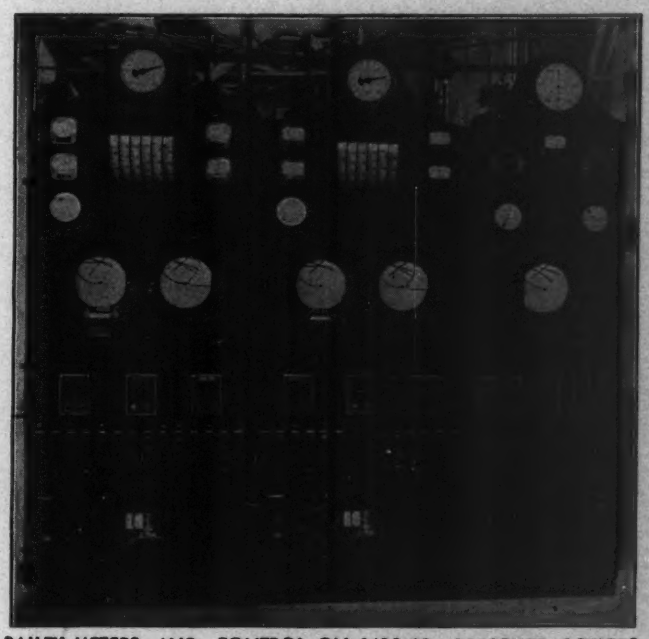

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The TECH ENGINEERING NEWS

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Among Our Authors

DR. W. F. G. SWANN, author, physicist, teacher, and executive of repute, is director of the Bartol Research Foundaton of the Franklin Institute and president of the American Physical Society. He has done much research in the field of atmospheric electricity and terrestrial magnetism, and developed the atmospheric equipment used by the yacht *Carnegie* on her world survey and by the Observatory in Washington. Other activities in this field have comprised critical examinations of possible explanations of terrestrial, atmospheric, electric, and magnetic phenomena. He is the author of many papers on relativity, electrodynamics, atomic structure and allied fields.

Dr. Swann received his early education in England. He has taught at the University of Sheffield, University of Minnesota, the University of Chicago, Yale, and is connected with the Carnegie Institute.

Technology students will remember Dr. Swann as a recent lecturer at the Institute, when he spoke in connection with the Faraday celebration.

MR. D. McFARLAN MOORE, author of the article on Luminous Tubes, has done a considerable amount of research in the field of illumination. He invented the tubes which made possible the advertising signs which are now so common. He produced the first successful television lamps and has made many improvements in television technique.

Mr. Moore has written many scientific papers and is a prominent lecturer. He is a Fellow of the American Institute of Electrical Engineers and a member of the Illuminating Engineering Society and the New York Electrical Society. Mr. Moore has been successfully connected with several business enterprises, and is now the manager of the Moore Light Department of the General Electric Company.

MR. A. P. M. FLEMING, C.B.E., M.Sc., M.I.E.E., author of "A Million Volt Air Condenser," has done a vast amount of research work in determining the industrial worthiness of modern electrical equipment. He has designed and superintended the manufacture of upwards of three million kilowatts capacity of transformers of all types and sizes. Mr. Fleming has spent much of his time in industrial education and research, having organized the British Westinghouse Works School and designed and built the extensive Research laboratories at Trafford Park, Manchester, England. He is a special lecturer at Manchester University on Industrial Management and has written many books and scientific papers on this and other subjects among which is his book entitled "Industrial Research in the U. S. A."

MR. A. F. DAVIS, author of "Arc Welding in Machinery Manufacture," is vice-president of the Lincoln Electric Company, Cleveland, Ohio, and an author and speaker of repute in the field of electric welding.

Mr. Davis began his career in the welding industry in 1914, after graduating from Ohio State Un versity with a degree of M.E. in E.E.

He has been connected with the industry since its very inception and has taken an active part in the development of arc welding generally.

MR. J. A. SUMMERS is a native of Pennsburg, Pennsylvania, and a graduate of Pennsylvania State College where he specialized in electrical engineering.

From college he spent two years on the General Electric Student's Test Course, after which, in 1912, he joined the Edison Lamp Works Illuminating Engineering Department at Harrison, New Jersey. During this time he was identified with the early developments of floodlighting and all forms of special lighting problems.

With the consolidation of the Engineering Department of the Edison Lamp Works and the National Lamp Works, he was transferred to Cleveland and placed in charge of the sports lighting and floodlighting department, which position he now holds.

MICHAEL FARADAY

FOR his many and varied discoveries in the fields of electricity, chemistry, and physics, Michael Faraday rightly deserves a high place among scientists. His discovery of the principle of induction has made possible in a large degree the great electrical industry of today. In addition he experimented with chlorine and chlorine compounds, diffusion of gases, alloys of steel, optical glass, established the identity of electrification produced in different ways, established the law of definite electrolytic action of a current, and made the first important discovery of the reaction between polarized light and a magnetic field, a discovery which is doing much to establish the actual condition of natural force.